Journal of the
Royal Microscopical Society

CONTAINING ITS TRANSACTIONS AND PROCEEDINGS

AND

A SUMMARY OF CURRENT RESEARCHES RELATING TO

ZOOLOGY AND BOTANY
(principally Invertebrata and Cryptogamia)

MICROSCOPY, &c.

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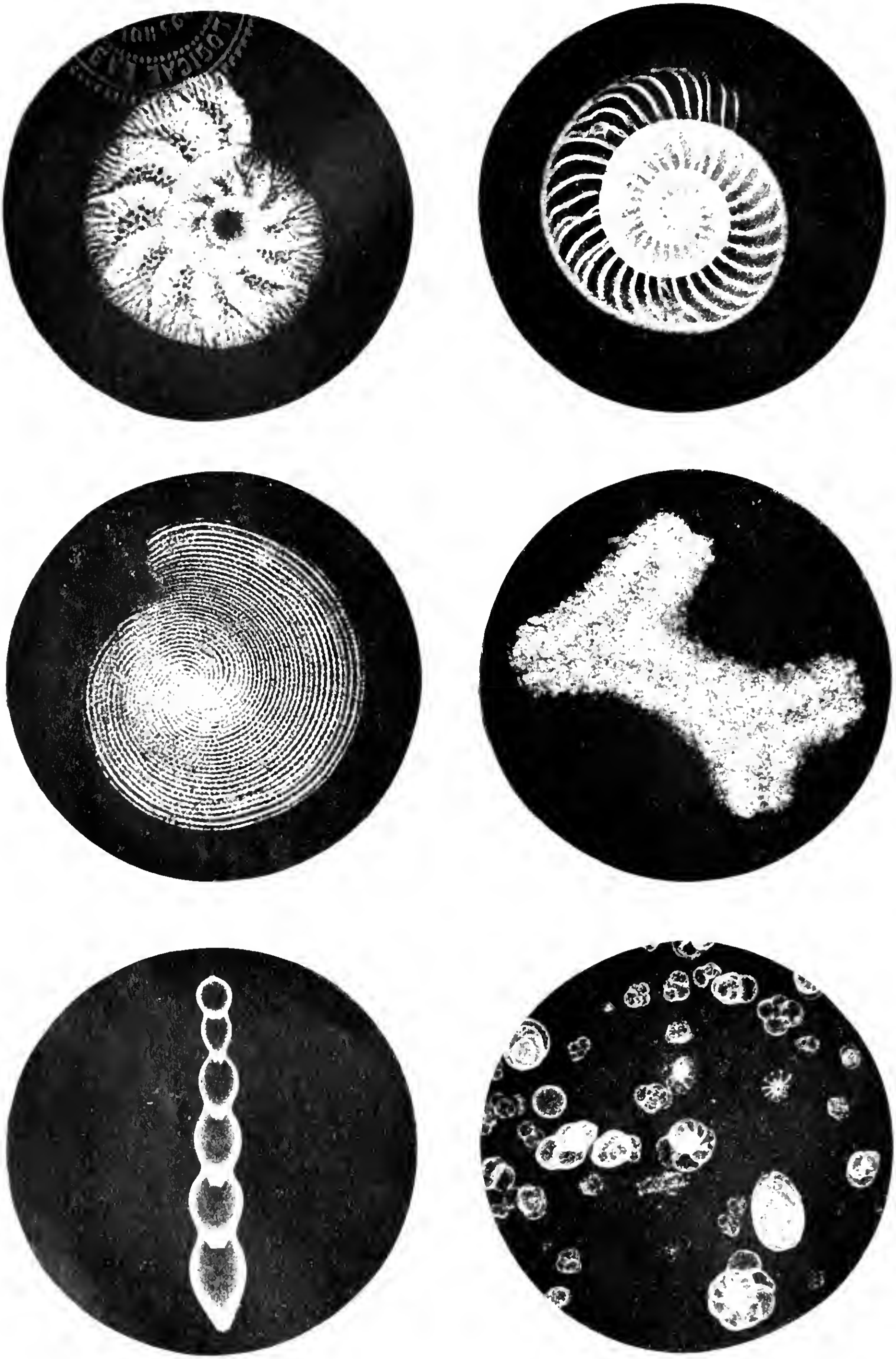

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JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

FEBRUARY, 1915.

TRANSACTIONS OF THE SOCIETY.

I.—*X-rays in Relation to Microscopy.*

By J. E. Barnard.

(*Read December* 16, 1914.)

Plate I and Fig. 1.

In the Journal of this Society for August 1913 there appeared an abstract of a paper by Pierre Goby on the radiography of microscopic objects, the original of which appeared in the Comptes Rendus previously. I read this paper with considerable interest, but I must confess that I was disappointed to find that there was little fresh information to be gained from it. There was much unnecessary elaboration of apparatus, and essential practical details were not described. I therefore came to the conclusion that the

Note.—Since reading this paper, I find that in the Comptes Rendus for January 25, 1897, Radiguet refers to the use of Röntgen rays for obtaining photo-

EXPLANATION OF PLATE I.

Fig. 1.—*Cyclammina cancellata.* × 25. This gives such a view of the labyrinthic wall-structure as could otherwise have been demonstrated only by means of thin sections.

,, 2.—*Operculina complanata.* × 20.

,, 3.—*Orbiculina adunca.* × 25. The species is normally opaque, and the internal structure is barely visible by incident light.

,, 4.—*Astrorhiza arenaria.* × 20. The branching tubular body-cavity is perfectly displayed in spite of the thick encrusting sand of the tubes.

,, 5.—*Nodosaria* sp. × 15. Illustrating the budding-on of successive chambers; the mouth of each chamber is seen visibly projecting through the base of the next.

,, 6.—Foraminifera as dredged (North Sea F.C. 'Goldseeker'). × 40.

method was not one which would lead to any important results. Very soon after this the work of Laue, Friedrich, and Knipping on the use of X-rays in elucidating the structure of crystals was described in the scientific press. As a consequence of this, not only was the molecular structure of crystals exactly demonstrated, but it was shown that X-rays were in all probability a form of light, differing only in wave-length. This work was followed up by Bragg in this country, and it constitutes one of the greatest advances in physical knowledge that has been made in recent years. The important facts that X-rays could be reflected from a crystal surface, that the arrangement of molecules in certain crystals could be elucidated, and the nature of X-rays themselves determined, have all arisen from these experiments.

If we examine the position of Microscopy at the present time, we are confronted with the fact that for the last thirty years, with one exception, there has been no actual advance in microscopic optics. We know perfectly well, too, that theory and practice are almost in agreement: that the optician has been able to produce lenses so nearly perfect that they almost reach the theoretical limit. The only method by which any substantial increase in numerical aperture, and consequent resolution, has been obtained is by the use of ultra-violet light, the method first devised by Kohler. The whole optical system is in this case of quartz, and the source of light is an electric discharge between cadmium or magnesium electrodes. It is an apparatus which needs considerable skill in use, and the results to be obtained by it are in some respects limited, as ultra-violet light is so easily stopped by organic substances. Yet it is possible by that method to make use of an objective which has an effective numerical aperture of 2·5, and resolution is increased substantially, therefore, beyond the utmost that can be obtained by any other means. It has, however, not really taken us very much further in practice, partly owing to the difficulty of using the apparatus, and also because of its high initial cost.

The method, in fact, while of the greatest interest and utility —as I have found from my own experience—is not one that the microscopist may be expected to take up for general use.

graphs of microscopic objects, using the term "microradioscopy." He further indicates that he had in view the production of a grainless fluorescent screen, the image on such a screen being magnified so that a direct micro-radiograph is obtained. For this purpose he used different varieties of glass from the Saint Gobain manufactory, some of which fluoresced under the influence of X-rays, while others were opaque. The method, therefore, appears to consist of magnification of the fluorescent image, the direct X-rays being stopped by the opaque variety of glass referred to, which is placed between the fluorescent screen and the magnifying system. It is doubtful whether such a method could succeed in practice, as no artificial substance, such as glass, is likely to fluoresce so brightly as the mineral substances I have experimented with.

It appears probable that in the present state of knowledge no advance in Microscopy will be made on optical lines, but if it is possible to utilize some new source of energy, then there is some hope that advances may be made—advances, I venture to say, that are at present beyond our imagination. We shall, as a result, be able to go far beyond the limits that at present seem so impenetrable.

On reading carefully the records of the work referred to on X-rays and crystal structure, I was at once impressed with the idea that, if we could in any way use X-rays as a source of energy for microscopical work it would take us a great deal further. X-rays are in order of wave-length something like one-thousandth that of the Schumann waves in the ultra-violet spectrum. Assuming that some means of utilizing them to the full is found, it should be possible to demonstrate structure and to obtain resolution that is inconceivable by any method at present available.

I talked the matter over with Mr. Rheinberg at this time, and he was so impressed with the possibilities in this direction that I had the advantage of his collaboration in some preliminary experiments which we agreed to attempt. Unfortunately, he became engaged in other and more important work, and was obliged—temporarily only, I hope—to relinquish his share in the experiments.

It is at once only fair to say that so far as any practical result goes we did not achieve very much. It was a question, at first, of repeating the early experiments that had been made by the observers mentioned, and by Bragg in this country. We were able to get some reflected X-ray images from crystal surfaces and from mica films, and by using curved mica films we succeeded in changing the form of a reflected beam of X-rays. The problem to be solved at the present time is to find a method of expanding or contracting a beam of X-rays in the manner that a lens alters the form of the wave-front with ordinary light. If means could be discovered to effect this, not on the face of it an insurmountable obstacle, then X-rays have characteristics that would make them by far the most valuable source of energy at present known in microscopic work. If we consider the fact that X-rays are selectively absorbed by so many substances, we realize that even at present we are in a position to utilize them, apart from the question of obtaining greater magnification and resolution. That being the case, I was interested enough to make some experiments to determine how far one might be able to go in obtaining direct radiographs of microscopic objects, enlargements being obtained by photographic means, and I venture to think the results are not uninteresting.

It is perhaps advisable briefly to indicate the conditions under which X-rays are produced. An X-ray tube, as ordinarily con-

structed, emits radiations of various wave-lengths. If the waves are exceedingly short, the tube is referred to as a "hard" one, the rays emitted being termed "hard" rays. On the other hand, if the tube is not so highly exhausted, and emits rays of longer wave-length, the tube is then referred to as "soft" and the rays emitted are called "soft" X-rays. The difference between these two states so far as penetration is concerned is very marked. Hard X-rays will penetrate nearly all substances even if their thickness is considerable, but with soft X-rays penetration is not nearly so great; and for all small objects, which are in any sense microscopic, their use is indicated. The tube I have used is provided with a lithium glass window so that the soft X-rays are freely transmitted. Ordinary glass obstructs the softest X-rays very seriously.

If it were possible to produce X-rays of any given wave-length, in the same sense that we can obtain monochromatic light for ordinary work, it would help us considerably. There is much reason to think that this will be practicable before long. X-ray tubes as ordinarily constructed emit rays of varying wave-length, so that while you can get a "soft" tube emitting a preponderance of soft rays, yet there is a certain admixture of hard rays with it. Another point that influences the particular quality of the rays emitted, is the material of which the anti-cathode is made. As you are probably aware, X-rays are generated in an exhausted tube as the result of the impact of cathode rays on a metal surface, this metal surface then becoming the source of X-rays. By varying the material of which the anti-cathode is made, changes are produced in the character or wave-length of the X-rays emitted.

The method of producing the few radiographs I am showing you this evening is very simple. An X-ray tube is enclosed in a lead-covered box so that the rays cannot pass out except in the desired direction. There is a small aperture in the position occupied by the lithium glass window in the tube, and this is covered with a lead diaphragm which has a small central circular hole. There are two or more of these diaphragms one above the other, with a certain distance between, so that at a distance of 15–20 cm. from the tube a parallel beam of X-rays of very small cross section is transmitted. The object is then laid in a light-tight box in the path of the beam, the rays passing through the object and impinging on to a photographic plate which is placed in actual contact with the object. The photograph then results as in ordinary X-ray work.

The resulting enlargement is purely a photographic process. I found very early that the results were limited, at least in part, by the size of grain in the photographic plate; and any ordinary X-ray plates that I tried were not satisfactory from this point of view, although good enough for ordinary X-ray work. In the course of some ultra-violet light experiments which I had previously con-

ducted with the Kohler apparatus, Messrs. Wratten and Wainwright had supplied me with some very fine grain plates with exceedingly thin films of gelatin. I tried these and found them remarkably good, substantially better in fact than any X-ray plates I had tried. The results I am showing are in most cases from negatives on these plates.

The resulting radiographs are of course of the same size as the microscopic object, and photographic enlargement has to be resorted to to obtain whatever magnification is possible. As I have said, the photographic plate is a limiting factor, and I am therefore experimenting in a direction that Mr. Rheinberg has suggested, that is to make a plate that is entirely grainless. There are photographic processes in which a grainless image is produced, and it is on these lines I propose to proceed.

It occurred to me that it might be possible to obtain a fluorescent image and magnify that directly, and I therefore made some experiments in that direction. The image was received on a fluorescent screen and the visible image so obtained was reflected at right angles to the direction of the beam of X-rays by a right-angled prism, and this was picked up by a microplanar lens and so magnified. The result was not unpromising except that up to the present I have not been able to obtain a grainless fluorescent screen which gives a sufficiently brilliant image. With certain minerals, such as Kunzite or Willemite, I think it is possible that, given sufficient X-ray energy, one might obtain photographs in this way.

The question of exposure in the method described is not an easy one, as microscopic objects are usually thin, and the distance through which obstruction takes place is short, therefore small differences in exposure make very considerable differences in the result. I think from experiments I have made that it would be more satisfactory in dealing with different thicknesses of objects and with different resistances of the objects to X-rays, if one could vary, not the exposure but the softness of the rays, using, of course, softer rays for objects that are very transparent, and harder ones in the case of objects of greater opacity. This, however, is a point that is not easy to deal with in practice, although there is an X-ray tube on the market now which enables one to produce X-rays of any given quality and almost any given quantity, the two factors being controlled fairly exactly. Up to the present, however, I have not heard of one being made in lithium glass or with a lithium glass window.

The examples I am showing are almost entirely Foraminifera, not that they are the only objects to which the method can be applied, but because, owing to the kindness of Mr. Heron-Allen and Mr. Earland, I had quite a wealth of this material at my disposal for experimental purposes. There is, however, hardly

any branch of microscopic work to which the method is not capable of application.

The diagram, fig. 1, shows in section the apparatus used to

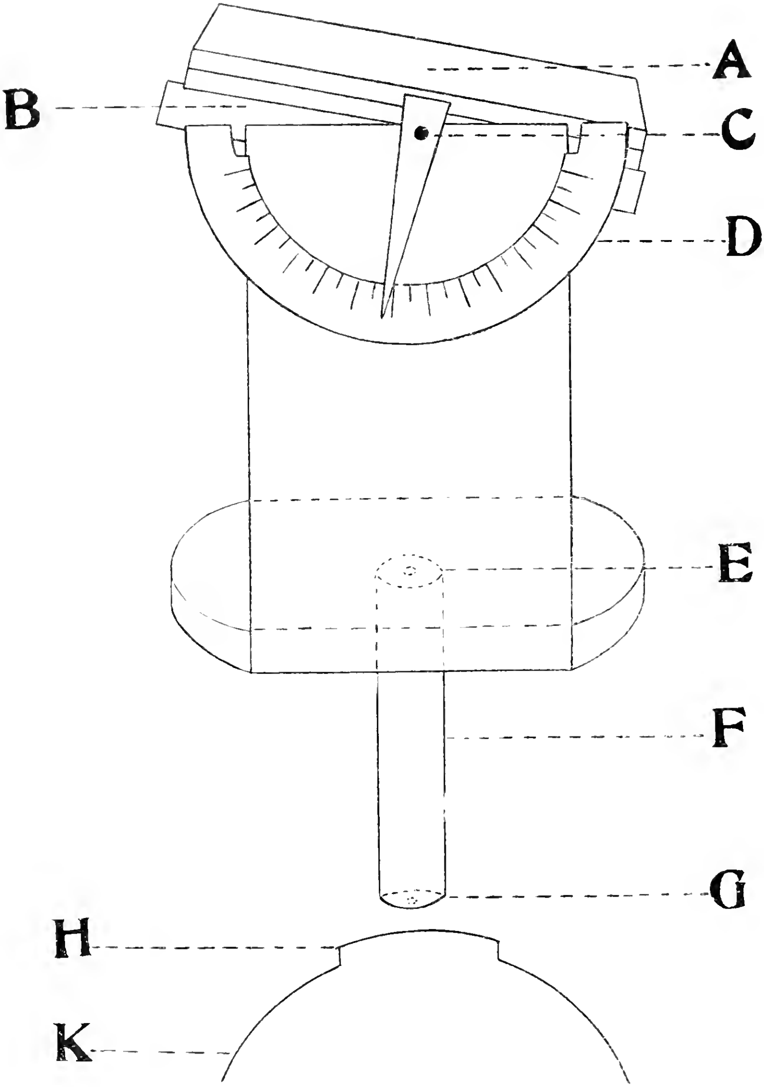


Fig. 1.

produce the illustrations herewith. A carries the photographic plate and the object. The latter is placed at B directly underneath

the plate and in contact with its sensitive surface. This box rotates on the centre C, the axis of which passes through the plane of the object. D is a quadrant showing the degree of deflection from the vertical. The object therefore can be photographed in any azimuth. A lead tube F is supported above the X-ray tube K and is closed at each end by the lead diaphragms E and G. The lithium glass window H is shown on the part of the X-ray tube facing the object-box, and allows a broad beam of X-rays to be emitted.

It is of interest to compare the wave-lengths of visible light with ultra-violet light, Schumann waves (the extreme ultra-violet not transmitted by air) and X-rays. It will be seen that the latter are of the order of one-thousandth of the wave-length of Schumann waves. There is therefore a wide gap to be bridged, but it is more than probable that physical research will very soon result in the production of radiations of this type, in fact much has already been done in this direction. The possibility of utilizing some of these intermediate radiations in Microscopy must always be borne in mind.

The following are the approximate wave-lengths referred to :—

Hertzian waves . . .	1000000 to 0·4 cm.
Infra-red waves . . .	0·13 mm. to 0·770 μ
Visible light rays. . .	0·770 μ to 0·360 μ
Ultra-violet rays . . .	0·360 μ to 0·2 $\mu = 200$ $\mu\mu$
Schumann waves . . .	0·1 μ = 100 $\mu\mu$
X-rays	0·1 $\mu\mu$, about

I am convinced that the possibility of using X-rays or some allied radiation as a source of energy for microscopic work is not merely a possibility, but is a problem the solution of which is a reasonable certainty. It may be a long time before a definite result is secured; on the other hand the progress of physical science is so rapid that at any moment a development may occur which will put the whole matter on a different plane. For my own part, I feel so convinced of the certainty that results will be obtained that I am determined to follow the matter up with such facilities, limited though they be, as are at my disposal.

OBITUARY.

August Weismann. 1834–1914.

In our necessary preoccupation with the war, little attention is being given to the passing of great men. The death of a scientific Nestor holds the public interest less than the loss of a ferryman's hut on the Yser; and it cannot be otherwise. But the ideal of a republic of science will, we trust, survive the present tragic conflict of nations; and in the light of that hope, as well as in gratitude, we would pay respectful homage to Weismann's memory. Professor and Geheimrath, recipient of the Darwin-Wallace medal and many honorary degrees, he remains to us "Weismann" and one of the makers of biological history. He was elected an Honorary Fellow of this Society in 1879.

Of his life apart from his scientific work we know little. He was born at Frankfurt-on-Main on January 17, 1834; he studied medicine at Göttingen; he went after graduation to Rostock, Vienna, Italy, and Paris, and was for some time private physician to Archduke Stephen of Austria. In 1863 the attraction of zoology became imperative, and he went to study under Leuckart at Giessen. Three years afterwards he went to Freiburg in Breisgau as Professor Extraordinarius, and soon succeeded to the chair which he held with so much distinction for about forty years. For many years, owing to a severe eye-trouble, it was impossible for him to do much microscopical work except at intervals. But he never gave up the habit of hard thinking, and it is less than two two years ago that he completed the arduous task of revising his "Evolution Theory." True to the older tradition of German professors, Weismann lived for his work and allowed nothing to distract him. He was fond of country walks and of music. (His son has, we believe, made a name for himself as a composer.) While he was a keen intellectual combatant, Weismann seemed to us, when we had the privilege of knowing him a little, essentially a man of peace, caring much more for truth than for any personal success in controversy.

Weismann's early work was strictly zoological, and his researches on the development of Diptera, the origin and movement of the germ-cells in Hydromedusæ, the eggs of Daphnids, and the seasonal dimorphism of Lepidoptera, are well known. As the years passed, he turned his attention more and more to the deeper problems of biology; and from 1883 onwards he published

a succession of essays on heredity and other problems, such as length of life, the immortality of the Protozoa, death, the significance of sexual reproduction. These excited great interest and stimulated research and enquiry. His studies on the Hydrozoa led him to the important idea of the continuity of the germ plasm, which has passed into the body of biological doctrine as a general explanation of the everyday fact that like tends to beget like.

From the idea of the continuity of the germ-plasm, Weismann worked logically onwards towards two great results—on the one hand, the elaboration of a hypothetical picture of the organization of the physical basis of inheritance (expressed in his famous "Germ Plasm"); and, on the other hand, the destructive criticism of the evidence on which had rested the widespread belief in the transmission of somatic modifications (structural changes acquired in the lifetime of an individual organism as the direct result of peculiarities in environment and function). His idea of constituents in the germ-plasm corresponding to every independently variable and independently heritable character has been continued into the more recent conceptions of germinal factors, determiners, or genes corresponding to the unit characters of the Mendelians and Mutationists. His scepticism as to the transmission of individually acquired modifications has had a great influence and has prompted some very important investigations and not a little careful thinking. Perhaps the most characteristic expression of Weismann's mind is the hypothesis of germinal selection, by which he sought to account for definiteness in variation, for it illustrates his resolute power of following an idea to its logical consequences. He adhered with the strongest conviction to the Darwinian view of the importance of selection as a directive factor in evolution, but he widened and deepened the doctrine with clearness and subtlety. Many biologists of to-day are far from accepting "Weismannism," but we are all agreed in recognizing the stimulating influence which he has exerted, and in admiring the nobility and sincerity of his life and work.

J. A. T.

SUMMARY OF CURRENT RESEARCHES

RELATING TO

ZOOLOGY AND BOTANY

(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),

MICROSCOPY, ETC.*

ZOOLOGY.

VERTEBRATA.

a. Embryology.†

Sex-determination in Pigs.‡—G. H. Parker refers to the hypothesis of Seligson that in Mammals the right ovary gives rise to ova that produce male offspring, the left to ova that produce female offspring. If this were so, the pairs of embryo pigs in the part of the uterus next the right ovary ought to be predominantly males and those next the left predominantly females. This is not the case. Pairs of embryos composed of two males or of two females occur in about the same proportions next the right ovary and next the left. A very similar proportion occurs at the division of the horns of the uterus. Although the sex of the offspring is thus shown not to be correlated with the side of the body from which the ovum that gave rise to the young came, it might be supposed that in any female a given ovary would always produce offspring of the same sex. In that case we should expect to find the great majority of pairs of young next the ovaries to be either both males or both females. But there are almost as many pairs composed of one male and one female next the ovaries as there are at the division of the horns. It may be concluded that in the pig each ovary produces ova which may give rise to either male or female offspring. For the albino rat it has been shown by Doncaster and Marshall, and by King, that a single ovary may give rise to ova which produce both sexes.

Litters and Nipples in Swine.§—G. H. Parker and C. Bullard found that 1000 litters of unborn pigs contained 5790 individuals; the

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, etc., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so-called, but also those dealing with Evolution, Development, Reproduction, and allied subjects.

‡ Science, xxxix. (1914) pp. 215–16.

§ Proc. Amer. Acad., xlix. (1913) pp. 399–426.

mean number of pigs per litter being 5·97, the mode 6. Of the 5790 pigs, 3024 were males and 2946 were females; 102·6+ males to 100 females. In the whole population the nipples ranged from 8 to 18, with a mean of 12·2+ and a mode of 12. In the male pigs the nipples ranged from 9 to 18, with a mean of 12·4+ and a mode of 12, and a standard deviation of 0·6906 ± 0·0060. In the female pigs the range was from 8 to 18, with a mean of 11·9+, a mode of 12, and a standard deviation of 0·7905 ± 0·0069.

On the left side the nipples ranged from 4 to 9, with a mean of 6·1 and a mode of 6; on the right side they ranged from 4 to 10, with a mean of 6·1−, and a mode of 6. The coefficient of correlation for the two sides was 0·6063 ± 0·0055. In the whole population the arrangement of the nipples fell under the regular plan (one in which the nipples are grouped in pairs right and left) in 3559 cases, and under the irregular plan (one in which the members of the right and left series show no obvious pairing) in 2411 cases.

There is no obvious relation between the size of the litter and the number of nipples in the females. Though there may be as few nipples as 8 and as large litters as 15, disadvantageous combinations of large litters borne by females with a few nipples cannot be of frequent occurrence. Commonly, there are about twice as many nipples (12) as young (6).

Experimental Parthenogenesis in Sea-urchins.* — M. Herlant maintains (against Loeb, Hindle, and Retzius) that the two poles of the first mitosis in the parthenogenetic cleavage of the Echinoid ovum do not result from the division of the female centrosome. The fact is that the female centrosome, without dividing, forms one pole; and the other is a cytaster. The action of the hypertonic solution results in the formation of a cytaster which secondarily enters into relations with the monaster arising from the female pronucleus and its centrosome. A perfect achromatin spindle is formed between them, and the chromosomes form an equatorial plate. The opportune intervention of the cytaster secures the transformation of the monaster, produced by activation, into a bipolar mitosis. An abortive figure, incapable of leading to segmentation, is transformed into one which provokes segmentation and leads on to the development of the egg.

Studies on Germ-cells.† — Robert W. Hegner has studied germ-cells (of insects in particular) with reference to the Keimbahn determinants, that is to say, visible substances which are present in the egg before cleavage begins, and later become part of the material contained in the primordial germ-cells. The following events may be recognized in the history of the Keimbahn determinants:—Localization of the Keimbahn determinants in the oocyte or mature egg; association of one or more cleavage nuclei with part or all of the Keimbahn

* Comptes Rendus, clix. (1914) pp. 408–10.
† Journ. Morphol., xxv. (1914) pp. 375–499 (74 figs.).

determinants to form one or more primordial germ-cells; the apparently equal distribution of the Keimbahn determinants between the daughter germ-cells at each mitotic division (*Sagitta* possibly excepted); the disappearance of the Keimbahn determinants in the oogonia and spermatogonia; the reappearance of the Keimbahn determinants in the oocyte or mature egg. The most interesting period in the germ-cell cycle is that extending from the formation of the ultimate oogonia and spermatogonia to the complete segregation of the germ-cells in the developing egg. A little known and important part of this period is that during which, in some animals, visible substances (Keimbahn determinants) peculiar to the germ-cells appear, become localized in a definite part of the egg or in certain blastomeres, and are equally distributed among the primordial germ-cells. The Keimbahn in animals was first traced in dipterous insects. Keimbahn determinants appear in the eggs of all Diptera that have been carefully studied (*Miastor*, *Chironomus*, *Calliphora*). In *Miastor* there are six cell-divisions during the multiplications of the oogonia. The somatic cells lose part of their chromatin by diminution processes, whereas the germ-cells possess a complete amount of chromatin. The nurse-cells are of mesodermal origin. A peculiar mass of cytoplasm becomes situated at the posterior end of the oocyte; within this one of the first eight cleavage nuclei (with a complete amount of chromatin) becomes embedded; it is then cut off from the rest of the egg as the primordial germ-cell. The origin of this peculiar mass of cytoplasm could not be determined. The eggs of the ovoviviparous Dipteron *Compsilura*, and of the willow-cone gall-fly, *Cecidomyia*, contain Keimbahn determinants which have a history like that of similar bodies in other insects. An early segregation of germ-cells has been reported for certain Chrysomelid beetles, and Keimbahn determinants have been found in the eggs of those carefully examined. An examination of all stages in the early cleavage of Chrysomelid eggs failed to reveal a chromatin-diminution process such as occurs in *Ascaris* and *Miastor*. The conclusion is reached that the cleavage nuclei are all potentially alike, and that the cytoplasm controls their differentiation into the nuclei of blastoderm cells, primordial germ-cells, and vitellophags. What appears to be amitotic nuclear division among the vitellophags is described. The pole-disc granules in Chrysomelid eggs form a recognizable mass just before the oocyte reaches its full size; their genesis could not be definitely determined In the testis of *Leptinotarsa* the germ-cells in each cyst arise from a single spermatogonium. Spindle-remains connect the daughter-spermatogonia up to the time when sixty-four cells are present in each cyst. This process is homologous with the differential divisions in *Dytiscus* and other beetles, and certain Hymenoptera, during which an ultimate oogonium and a definite number of nurse-cells arise from a single oogonium. What appears to be amitotic nuclear division was found among the nurse-cells of *Leptinotarsa*, but no nuclear phenomena which could be interpreted as amitosis were observed among the oogonia or spermatozoa. Most of the author's own experiments and observations refer to Chrysomelid beetles, but he describes work done by other investigators on the Keimbahn in Crustacea, in *Ascaris*, *Sagitta*, and

other forms. He concludes that, though the nature of the Keimbahn determinants remains uncertain, their origin from metanucleoli, nurse-cells, and possibly the nutritive stream, suggests that they may play a role in the nutrition of the germ-cells during the period extending from their segregation until the formation of the definitive germ-glands.

A very full bibliography is appended to the paper.

Development of Nerves of the Head in Fishes and Amphibians.* A. Goette has studied this subject in *Petromyzon fluviatilis*, *Torpedo ocellata*, *Amia calva*, and *Siredon pisciformis*. He first discusses the metamerism of the ecto-mesoderm of the head, and he then passes to particular nerves. The olfactory of Selachians arises from several bud-like outgrowths of the olfactory epithelium and their union into a ganglionic body, which grows centripetally and unites with the brain. In Amphibians, in spite of appearances, it also arises from the olfactory epithelium.

The auditory of Fishes and Amphibians is not a branch of the facial ganglion ; it arises from a proliferation of the labyrinth-epithelium, which forms an associated ganglion. The differentiation of nerve-strands passing from the epithelium into the ganglion gives rise to the formation of the several auditory branches. This is certainly so in *Torpedo*, and probably so in *Siredon*. The union with the facial is subsequent and secondary.

In the vagus complex of the lamprey there are three centrogenous spinal nerves (glossopharyngeal, vagus, and first spinal nerve of the trunk), an ectodermic lateral nerve primordium, and five ectomesodermic visceral ganglia.

In the vagus complex of *Torpedo* there are united (1) a complete spinal nerve with its own ganglion—the vagus ; (2) four ectomesodermic visceral ganglia ; (3) an undivided and non-ganglionated occipital ganglionic ridge, uniting the visceral ganglia and their nerves with the spinal cord ; and (4) a lateral ganglion extending through the whole vagus and occipital region.

The lateral nerve stem in *Siredon* does not develop independently of other parts, secondarily sending out lateral twigs to the terminal organs. It arises rather from the commissures which connect the lateral organs and are evoked by them. The lateral twigs are wholly due to the drawing back of the nerve stem from the lateral organs.

Goette cannot confirm in Fishes or Amphibians the centrogenous origin of the nerves of the eye-muscles or their interpretation as motor roots of the spinal nerves. The fact is that these nerves come into secondary connexion with the brain. They arise as a rule from their muscles or the adjacent mesenchyme, and in rare cases from other nerves.

These eye-muscle nerves arise from indifferent formative cells which form a syncytium. The fibres arise first in the distal portions and grow centripetally into the brain, where they unite with ganglion-cells. The syncytial primordium forms the sheath as well as the fibres.

The ganglionic primordia of the lateralis, vagus, and visceral ganglia are at first syncytial. From these syncytia there are differentiated first

* Arch. Mikr. Anat., 1te Abt., lxxxv. (1914) pp. 1–165 (10 pls. and 6 figs.).

the nerves, then the elements that form ganglion cells, and finally the interstitial enveloping tissue.

The ganglion cells are secondary formations in the embryonic ganglion-primordia, and their union with the nerve fibres which are already in part formed is a secondary process. The nerve-fibres of the lateral nerves develop independently of any neuroblasts within the syncytial plasma of the primordium, and they enter subsequently into connexion with the ganglion cells.

Tissue-formation is the visible expression of the organization associated with a function. Nerve-formation is the visible expression of the progressive localization and differentiation of the pre-existing correlation between the sensory stimulus and the contraction. The active cause of the histogenesis is the transmission of the stimulus. There are no preformed nerve-formers, but the formative material of the nerves is determined to its histogenesis and topographical alteration by external influences. The causes of nerve-formation are (1) the active transmission of stimulus which has a histogenetic capacity, and (2) the morphological conditions affecting the course of the nerve. These are some of the main conclusions of an elaborate investigation.

Eye-muscle Nerves.*—H. V. Neal begins an important study of the morphology of the eye-muscle nerves with an account of the histogenesis of spinal somatic motor nerves in *Squalus* embryos. Nerve and muscle are not primarily connected. Previous to the establishment of protoplasmic connexion, the space normally found between somite and neural tube is filled by a vacuolated non-staining, non-protoplasmic liquid containing a relatively small amount of coagulable material. Protoplasmic connexion of somite and tube is established by an amœboid protoplasmic extrusion from cells in the ventro-lateral wall of the neural tube, forming the "protoplasmic bridges" of Paton or "plasmoderms" of Held. The cell processes which form these connexions extend gradually along the median surface of the somite between myotome and sclerotome. Within these processes the neurofibrils soon make their appearance. This evidence demonstrates the neuroblastic nature of the cells which form the protoplasmic connexions between tube and somite, and their processes are therefore to be regarded as neuraxons. The cell-chain hypothesis of neurogenesis receives no support from the evidence presented in sections of *Squalus* embryos. The neurofibrillar structure appears in the nerve primordia before any cells are present in them.

The growth of a nerve-fibre toward its terminal organ does not involve the use and resorption of primary plasmatic paths, but simply the movement and differentiation of the protoplasm of the medullary neuroblast. The most convincing demonstration of the truth of this is afforded by the growth and extension of the processes of Rohon-Beard cells. The numerous cells which, in somewhat advanced stages of histogenesis, make their appearance in the ventral nerve primordia, are not of mesenchymatous but of medullary origin; exclusively so in the

* Journ. Morphol., xxv. (1914) pp. 1–187 (9 pls.).

earlier stages of development. That mesenchymatous cells are added to the growing nerve in more advanced stages to form the connective tissue sheaths, seems probable.

The cells of the motor nerve primordia have no genetic relations to the neurofibrils or neuraxons. In other words, they are not "nerve-cells" in von Apathy's sense, nor do they unite in chains to form the neuraxons or neurofibrils with their sheaths. Whether or not they participate in the formation of the sympathetic is an open question. The evidence on the whole favours, but does not prove, the conclusion that most of the cells of the sympathetic have their source in the dorsal ganglia. That the cells of the motor nerve primordia in *Squalus* for the most part form neurilemma cells, can be convincingly demonstrated. Thus the phenomena of spinal motor nerve histogenesis in *Squalus* support the conclusions of Kupffer, Bidder, His, Harrison, and Lewis.

The author passes to the histogenesis of the oculomotor, trochlear, and abducens nerves, and finds that it differs in no essential respect from the histogenesis of spinal somatic motor nerves. This creates a strong presumption that pre-otic and post-otic divisions of the Vertebrate body are fundamentally alike. The evidence in favour of the view that the oculomotor is a mixed nerve homologous with typical cranial nerves such as the trigeminal is so unconvincing, while the evidence of its histogenesis and its central and peripheral relations so strongly supports the view that it is a somatic motor nerve, that the acceptance of the latter view seems unavoidable. The trochlear and the abducens must also be ranked along with somatic motor nerves.

In the region of the fore-brain there is at least one metamere, serially homologous with the metameres of the trunk, but more cannot be safely said. The second metamere has the premandibular as myotome, the mid-brain as neuromere, the ophthalmicus profundus as the somatic sensory nerve, and the ciliary as sympathetic ganglion. The secondary splitting of the pre-mandibular myotome into dorsal and ventral moieties is evidently correlated with the development of the eyeball. The facts do not warrant the supposition that the oculomotor—the somatic motor nerve of this metamere—has a bimeric distribution. No one has been able to demonstrate the required two motor niduli. The premandibular is a single somite.

The third metamere has the mandibular for its myotome, and its neuromere is the cerebellum, within which lies the nidulus of the trochlear nerve, which is therefore the somatic motor nerve of the segment. The trochlear nerve becomes connected with the ramus ophthalmicus superficialis trigemini, the somatic sensory nerve of the metamere. There is evidence of a transient sympathetic primordium. While the chiasma of the trochlear is an anomaly, it may be regarded as cœnogenetic, and its existence does not invalidate the comparison of this metamere with a trunk segment. The ramus mandibularis trigemini appears to be the splanchnic motor element of this metamere.

The fourth metamere contains the third or hyoid myotome and the fourth neuromere (second hind-brain neuromere). To this segment may be assigned as the somatic sensory nerve the major root of the trigeminal in part. Since no neural crest is proliferated from this

neuromere, however, this assignment must be made tentatively, although the major root of the trigeminal is attached to this neuromere. The neuroblasts in the somatic motor column of this neuromere do not produce a nerve. The transient nerve seen in this region in chick embryos may be the somatic motor nerve of this metamere which has disappeared phylogenetically. The myotome of the metamere, however, is innervated by the nerve of a post-otic metamere, the abducens.

The fifth and last pro-otic metamere includes the fifth neuromere and the fourth somite which is partly sub-otic. To this position it presumably owes the loss of its myotome. To the degeneration of the myotome may be attributed the loss of the somatic motor nerve of this metamere. No sympathetic primordium develops in this segment and the somatic sensory components are also lost. But the proliferation of the cells of the facialis nerve from this neuromere justifies the inference that they once have been present in this nerve. The loss of the myotome of this and of the following somite, a loss in all probability due to the enlargement of nerve ganglia and sense organ in this region, tends to show that the preservation of the myotomes of the first, second, and third somites is due to their functional relation with the eye-ball. The eye muscles are the last remnants of the lateral trunk musculature anterior to the ear.

Regenerative Capacity of Lizards.*—G. Billiard reports on the recovery of a green lizard after it had been mauled by a cat. The tail, reduced to a stump, regrew six centimetres in the following year. But a lost hind leg, bitten across the femur, was not regenerated. The digits of another damaged limb simply formed a scar. Billiard concludes that the limbs are never regenerated, and he makes the suggestion that statements to the contrary are due to a confusion between newts and lizards! It may be noted that in Weismann's well-known discussion of regeneration it is stated that lizards do not regrow their legs.

Hermaphrodite Amphioxus.†—J. H. Orton reports that an hermaphrodite specimen of *Amphioxus lanceolatus* was taken at Plymouth, which closely resembled one taken by Goodrich at Naples. It had one gonadial pouch filled with ova and the remaining pouches filled with spermatozoa. The liver and intestine were abnormal, but no parasites were identified in the tissues to account for the abnormalities. It is improbable that there is any normal sex-change in *Amphioxus*. The three hermaphrodite specimens which have now been recorded have been very small. The hermaphroditism is probably comparable to that not unknown in some fishes.

Orton notes that the spawning of *Amphioxus* has been observed in June, and that larvæ have been obtained from captive specimens. It is suggested that the club-shaped gland may secrete a substance which attaches the larva to objects, and that this function may be correlated with the asymmetry shown in the early development.

* Bull. Soc. Zool. France, xxxix. (1914) pp. 327–9 (1 fig.).
† Journ. Marine Biol. Assoc., x. (1914) pp. 506–12 (5 figs.).

b. Histology.

Cultivation of Human Tumour Tissue in vitro.*—David Thomson and J. G. Thomson have definitely succeeded in cultivating *in vitro* portions of intracystic papilloma of the ovary (not truly malignant) and of carcinomatous gland from the neck (secondary to carcinoma of the floor of the mouth). In the first case, buds of new growing tissue appeared on the third day, and the new cells differed markedly from the original cells, being larger and with amœboid processes. In the second case, after 44 hours' incubation at 37·5° C., long branching stroma cells appeared growing out from the original tissue; and the new cells were again much larger than the original. It is interesting to note that these human tumour tissues were cultivated in a medium composed chiefly of fowl-blood plasma.

Melaniridosomes.†—E. Ballowitz continues his study of chromatophores, and describes a new type in the perch and the ruffe (*Acerina cernua*). The new type is a melaniridosome, which consists of a melanophore and an iridosome, i.e. a compacted aggregate of iridocytes (guanin-cells). The iridocytes are numerous and the processes of the typically central melanophore stream out between them.

Theory of Action of Rays on Growing Cells.‡—J. Joly compares the events taking place in a photographic film with those which occur in cells subjected to γ- and x-rays. The formation of the normal latent image by moderate light-stimuli is parallel with the stimulation of growth by feeble x- or γ-radiation. The photographic reversal by greatly increased illumination compares with the inhibition of growth by the heavy doses of γ-radiation now employed in the treatment of cancer. If, in the life of the cell, ions are naturally always being formed, the absence of a "restrainer" might lead to morbid ionization; or, again, the presence of a sensitizer. The former would limit the ionizing tendency either physically by its inert properties, or chemically. The latter would accelerate it by removing the products of reaction as fast as they are formed. It is interesting to note that excessive quantities of radium are found in certain tumours. If the cancer cell be the seat of excessive ionization, it may be possible to bring about reversal (as in the radio-active treatment) or to devise some chemical treatment which serves to discharge the ionized systems.

Structure of Skin in Anguidæ.§—W. J. Schmidt has made a detailed study of the integument in *Anguis fragilis*, *Ophisaurus apus*, and *Gerrhonotus liocephalus*. With especial reference to the first, he treats of the surface-relief; the melanophores and guanophores; the arrangement of melanophores in epidermoid, subepidermoid, and inferior groups; the change in coloration with age; the detailed structure of the

* Proc. Roy. Soc., Series B, lxxxviii. (1914) pp. 90–1 (1 pl.).
† Zeitschr. wiss. Zool., c. (1914) pp. 1–35 (3 pls. and 8 figs.).
‡ Proc. Roy. Soc., Series B, lxxxviii. (1914) pp. 262–6.
§ Zool. Jahrb., Abth. Anat., xxxviii. (1914) pp. 1–102 6 pls. and 25 figs.)

epidermis; the bony plates of the dermis; the development of the bony plates, which is wholly due to the median and inner layers of the dermis; and the integumentary sensory spots.

Nematocysts in various Groups.*—C. H. Martin publishes a note on the occurrence of nematocysts and similar structures in the various groups of the animal kingdom. He examines the evidence for the occurrence of such structures in Protozoa, Sponges, Turbellaria, Nemertinea, Mollusca, and Chordata. True nematocysts he regards as developed only in, and characteristic of Cœlenterates; and he classifies these, and structures in other animals which have been described as nematocysts as follows: 1. Autocnidæ: true nematocysts developed singly in a true nematoblast within the tissue of its possessor (Cœlenterates. 2. Cleptocnidæ: Cœlenterate nematocysts which have been ingested with the food, and are found unexploded in the tissues of their possessor (Æolids, Turbellaria, etc.). 3. Pseudocnidæ: often confused with true nematocysts, but not homologous. This group includes the nematocysts of certain Nemertines from which a spiral thread can be discharged; those of *Epistylis* and *Otoplana*, in which the thread is not preformed with the capsule, and those of Turbellaria in which no trace of a thread has been discovered. 4. Polar capsules: strictly analogous as regards development, structure and mechanism to true nematocysts, but confined to a single group of the Sporozoa. The author points out that if all these groups are regarded as homologous, their presence in such isolated instances in various groups would present great difficulties to the evolutionist. If they are analogous and have been evolved afresh in each case, they afford an amazing instance of what is apparently convergent evolution. The problem of the nematocyst position—so that when the thread is discharged it will pass out of the animal—is discussed and possible explanations are suggested, e.g. that the nematocyst exercises some stimulus on the cell which contains it, or, that the structure and shape of a hydroid nematocyst will, mechanically, set it at a certain angle under certain conditions of pressure, and that the resultant of these forces leads to the nematocyst under the skin always pointing in the right direction.

c. General.

Plankton.†—J. Graham Kerr first discusses the adaptations of the plankton. The macroplankton is illustrated by Medusæ, pelagic Annelids like *Tomopteris*, the *Leptocephalus*-stage of eels. Among their characteristic features may be noted the transparency (even hæmoglobin is suppressed in the *Leptocephalus*-stage), types of coloration which harmonize with the environment, the frequency of photogenic organs, the well-developed sense-organs, and the development of floats (like the swim-bladder of fishes). In the microplankton the problems of flotation are different from what they are in the case of larger forms. The natural rate of sinking of small bodies is very slow; the viscosity of the

* Biol. Centralbl., xxxiv. (1914) pp. 248-76.
† Buteshire Nat. Hist. Soc., 1914, pp. 1-9.

sea-water is of more importance. The specific gravity may be diminished by accumulating water or gelatinous material. An increased effect may be given to the viscosity of the water by the development of spiny or feathery outgrowths. The economic importance of the plankton is incalculably great. Thus each food-fish is dependent upon a food-chain; the organisms forming any link of the chain supporting those of the next link and being themselves dependent upon the next link in the other direction, while the chain ends in the physical conditions of the sea-water. A serious diminution in the numbers of fish in a given locality may be a fluctuation due to a weakening of a link in the food-chain. Or it may be due to migration away from accustomed haunts in company with shifting of the physical conditions suitable to one or other link. A scientific knowledge of the plankton must form the basis of practical action in such cases.

Changes in Breathing and Blood at High Altitudes.*—M. P. Fitzgerald publishes a record of further investigations into the changes in breathing and blood at high altitudes. Her present investigations were made on persons acclimatized up to 3850 ft., and the results confirm those gained in the earlier study, which included persons acclimatized from 5000 to 14,000 ft. The lowering of the CO_2 pressure is in direct proportion to the diminution of the barometric pressure, and amounts to about 4·2 mm., or 10·5 p.c. of the sea-level value for each 100 mm. of diminution of barometric pressure. In women, as at sea-level, the alveolar CO_2 pressure is about 3 mm. lower than in men. The percentage of hæmoglobin in the blood is increased at altitudes of 3850 ft., as at higher altitudes. For every 100 mm. fall of atmospheric pressure the percentage of hæmoglobin in the blood is increased by about 10 p.c. of the normal value for men at sea-level. In women, as at sea-level, the values are about 11 p.c. lower than for men, but greater irregularity is observed. Graphic representations and tables of the results are given.

Facial Vibrissæ of Mammals.†—R. I. Pocock finds that in all the principal orders of terrestrial Mammals some, at all events, of the species possess facial vibrissæ arranged upon a definite plan. In a great many cases, within the limits of a certain order, the species which are defective in the matter of vibrissæ are the higher derivative types, whereas those in which all or most of them are present are the more generalized types.

Except perhaps the suboculars, vibrissæ are primitive Mammalian features. They are disposed in five groups.—1. The buccal, including mystacials on the muzzle and upper lip, and the submentals on the chin and lower lip. 2. The interramal, an unpaired tuft of bristles, often symmetrically arranged, projecting from the interramal area behind the mandibular symphysis. 3. The genal, consisting of one or two tufts, or isolated bristles on the cheek. 4. The superciliary, forming a tuft over the eye, generally over its anterior portion. 5. The subocular, beneath the eye mainly in large Herbivora. The superciliaries and suboculars must not be confounded with the eyelashes. The vibrissæ

* Proc. Roy. Soc., lxxxviii. (1914) pp. 248–57 (2 figs.).
† Proc. Zool Soc., 1914, pp. 889–912 (13 figs.).

probably date back to a very early post-Cynodont stage of a Mammalian evolution, and their absence in Monotremes is a derivative feature associated with the transformation of the jaws.

The development or deficiency of vibrissæ is doubtless correlated with the mode of life. Pocock calls attention to some noteworthy points. There is a deficiency or complete absence of vibrissæ in all the ant-eaters, like *Echidna*, *Tamandua*, and *Manis*, quite unrelated genera. They are highly developed in thickness and length in piscivorous aquatic or semi-aquatic genera like *Chironectes*, *Potamogale*, *Lutra*, and *Cynogale*, and they are comparatively feeble or deficient in aquatic Herbivores, like the Sirenians, *Hippopotamus* and *Hydrochærus*. The Polar Bear is exceptional among predatory aquatic Carnivores for the poor development of the vibrissæ, but its ancestors had probably lost them before they took to the water. In the Primates they dwindle from lower to higher types, and this is probably correlated with the gradual perfection in the use and sensitiveness of the hand. They are highly developed in active aboreal species like squirrels, and reduced in size and number in slow climbers like sloths (*Bradypus*), Pottos (*Perodicticus*), and the tree-kangaroo (*Dendrolagus ursinus*). They are generally prevalent in the smaller burrowing, bush-frequenting, or forest species among Rodents, Carnivores, and others. They are decadent in larger forms like the Ungulates.

Organ of Jacobson and Palatine Cartilage.*—A. Arnbäck Christie-Linde describes the structure of the organ of Jacobson in *Sorex*, *Crocidura*, *Tupaja*, and other types. It is relatively complicated in *Tupaja* and *Gymnura*, but it is possible that this may be due to a difference of sex. It is probable that the Insectivora are descended from Vertebrates in which the organ of Jacobson was of a more complicated structure than is now generally met with in Mammals (excepting Monotremes). The same type of Jacobson's organ occurs in widely different groups.

The cartilago palatina lies between the palatine processes of the premaxillæ and maxillæ. It is most probably homologous with the processus palatinus of Gaupp in *Echidna*. It belongs to the primordial cranium, and is originally a process from the floor of the cartilaginous nasal capsule into the region of the secondary palate. It is present in Lacertilia. It is rudimentary in *Tupaja*, *Macroscelides*, *Sorex*, *Lepus*, Bats, Lemurs, and higher Mammals generally.

Rate of Growth in Marine Invertebrates.†—J. H. Orton publishes a preliminary note on an investigation into the rate of growth of marine Invertebrates which he began in 1911. The particular objects of his research are: to establish the age of common marine Invertebrates; to determine the minimum age at which these forms begin to breed; to examine the rate of growth at different seasons of the year and under different conditions; and to investigate as far as possible the fecundity of different forms. He finds that the rate of growth in many forms is much more rapid than has been suspected. Thus many species of

* Morphol. Jahrb., xlviii. (1914) pp. 343–64 (14 figs.).
† Journ. Marine Biol. Assoc., x. (1914) pp. 312–36.

Cœlenterata give off medusæ when not more than a month old. The commonest species of *Tubularia*—almost certainly *Tubularia larynx*—was found to give off actinulæ larvæ at an age of six weeks, and in one experiment this form had moderately developed gonophores in 26 days. As these actinulæ have been found to settle and grow into polyps within a few days, it follows that this species may pass through its life-cycle within six weeks, and probably under favourable conditions within four or five. Plumularia and Gonothyræa may complete their life-cycle in three months, and in both cases probably in a period shorter than that by some weeks if the conditions are favourable. Most of the Cœlenterate species investigated appeared to have a maximum rate of growth in the months of August and September. *Sagartia viduata* was found to attain full size at a maximum age of sixteen months. Among Porifera, *Sycon coronatum* and *Grantia compressa* were specially investigated. They were found to be annuals, as has been generally believed. There are two breeding-seasons, summer and late autumn, and there was evidence that the same individuals may breed twice—once in late autumn and again in the following summer, after which they die down. Growth continues throughout the winter, and temperature appears to be the main factor in reproduction. Among Polyzoa, *Bugula flabellata* was found to grow to a good sized colony and give off larvæ within eight weeks. A raft moored at sea for six weeks was found to be covered with a growth of the hydroid *Obelia geniculata*, on which adult Nudibranchs, chiefly *Galvina picta*, were feeding. Masses of spawn of *G. picta* were found on the hydroids, and from these masses free-swimming veligers were given off. Thus, these Nudibranchs had undoubtedly peopled the raft as veligers, rushed through their development at the expense of the hydroids, and were giving off veligers again to populate hydroids elsewhere within a period of not less than six weeks and two days. Many other interesting examples of rate of growth and age of reproduction are given, but fuller accounts and more precise figures are reserved for a later paper. Meantime the investigator asks his readers for references to work on the same subject which they may know of.

Tunicata.

Colouring Matters of Diazona violacea.*—Alfred Holt refers to the fact that specimens of this rare compound Ascidian collected off the Outer Hebrides by Prof. Herdman have a green tint when alive, but change into violet when placed in alcohol, and give the alcohol a green colour. Natural violet specimens occasionally occur. The green colour probably results from some chlorophyll-like body. So far as is known, it is not due to chlorophyll in symbiotic Algæ. The pigment cells are far smaller than the algal cells in known cases of symbiosis. Moreover, the Ascidian has been collected from 60 fathoms.

The purple pigment is all but insoluble. Its behaviour resembles that of the dibromindigo from *Murex*, and it is perhaps an isomer. It also resembles that in *Purpura* and *Bonellia*. The experimental evidence

* Proc. Roy. Soc., Series B, lxxxviii. (1914) pp. 227–36.

so far available does not enable one to ascribe any certain origin to the violet pigment, nor to account for its development in such different organisms as *Murex*, *Purpura*, *Bonellia*, and *Diazona*.

Tunicates of Santander.*—E. Rodriguez y López Neyra de Gorgot gives a short account of Tunicates collected at the Marine Biological Station of Santander. The collection includes four species of *Salpa*, two of *Molgula*, four of *Ascidia*, two of *Leptoclinum*, and so on. A diagnostic key is given, and some illustrations of the branchial apparatus of Ascidians and of the spicules of some compound forms.

Circulation and Luminescence in Pyrosoma.†—Fritz Burghause describes the heart and circulation in the ascidiozooid of *Pyrosoma giganteum*, and refers more briefly to the cyathozooid. He deals with the various blood-sinuses; the course of the circulation, as compared with that of Ascidians and Salps; the importance of the food-carrying function; the periodic reversal of the heart; the influence on the heart's activity of stimuli affecting the surface of the body; the influence of lack of oxygen; the influence of products of metabolism; the influence of alterations of temperature; the changes that occur during the moribund period. The luminescence is not due to the direct oxidation of a luminous substance; it has its seat in the luminous organs, the ovary, and the embryo in the cloaca; the colour observed was always greenish-blue; the luminescence of other animals serves to exite that of *Pyrosoma*; direct sunlight is prejudicial. Experiments showed that the luminescence had no protective value as far as fishes and crabs were concerned.

INVERTEBRATA.

Mollusca.

γ. Gasteropoda.

Apparent Absence of Sexual Characters in Shell of Neritina fluviatilis.‡—A. E. Boycott and J. W. Jackson have examined nearly 300 shells of this fresh-water Gasteropod to see whether the sexes differed in size, shape, texture, colour, or other external features. They were not able to find any sexual characteristic. The examination of about forty radulæ showed no sexual difference.

δ. Lamellibranchiata.

Luminous Organs and Nervous System of Pholas dactylus.§ J. Förster describes five luminous organs in this bivalve—two narrow parallel stripes on the septum in the branchial siphon, two irregular spots in the mantle, and a horseshoe-shaped organ on the posterior

* Mem. R. Soc. Española Hist. Nat., ix. (1914) pp. 489–512 (10 figs.).
† Zeitschr. wiss. Zool., cviii. (1914) pp. 430–97 (2 pls., 5 figs., and 9 tables).
‡ Ann. Nat. Hist., xiv. (1914) pp. 369–75 (2 figs.).
§ Zeitschr. wiss. Zool., cix. (1914) pp. 349–92 (1 pl. and 15 figs.).

portion of the pedal aperture. All are situated on the internal mantle surface. Each is composed of a large number of individual glands embedded in loose connective-tissue, and emptying their contents into the mantle cavity by narrow efferent ducts. According to the nature of the secretion, mucin-glands and luminous glands may be distinguished. The mucin-glands produce a homogeneous mucus; the others a fluid secretion and a granular material. The cells are not used up in forming the secretion, but what is exuded is replaced during a resting period succeeding the emptying. The luminous secretion arises by a granular transformation of the homogeneous content of the cavities of a coarse meshwork. The innervation muscles and vascular supply of the luminous organs are carefully described.

The secretion expressed by the muscles is luminous when it touches the water. It is extracellular as in Copepods and Ostracods. The luminescence is not continuous; it stops after continued stimulation, and does not reappear until after a rest. It follows that the elaboration of the luminescent material does not keep pace with the disassimilation.

The luminescent material is made by living cells, but it is not living, nor does it require a protoplasmic environment. It may be seen after decomposition has set in. In normal circumstances the luminescent material comes out in clouds from the opening of the siphon. With low-power magnification it appears as if the animal were surrounded by thousands of small stars. These consist of luminous granules within a sheath of mucin, which isolates the essential material.

Each luminous organ consists of three parts, the epithelium, a zone where the luminous secretion undergoes transformation, and the glandular tissue. Förster also gives a detailed account of the nervous system.

Arthropoda.

α. Insecta.

Stylopization.*—Geoffrey Smith and A. H. Hamm have studied the stylopization of a solitary bee, *Andrena nigroænea*, by *Stylops melittæ*, the adult female of which is a degenerate grub-like creature which remains permanently inside the body of the bee. The male, before hatching out as a winged insect, also develops inside the abdomen of the bee, undergoing its larval stages and pupation in this situation. The male pupa, in fact, closely resembles the adult female parasite, and protudes a little cap between the segments of the bee's abdomen to the exterior, which closely resembles the head of the female parasite which is similarly protruded. When the adult winged male emerges from its pupa and from the bee, it pushes off the protruded cap of the pupa and leaves the old empty pupal case inside the abdomen of the bee, where it can often be seen as a cavity opening to the exterior.

From a study of the structure and life-history of *Stylops*, it appears that, despite the existence of active winged males, fertilization cannot occur, and development is always parthenogenetic. The parasite obtains its oxygen from the outside air by means of tracheal openings on the

* Quart. Journ. Micr. Sci., lx. (1914) pp. 435-61 (4 pls.).

cephalothorax, and it does not possess any special absorptive organs for taking up a special kind of food from the host. Nutrition seems to take place by simple filtration from the host's blood through the very thin skin of the parasite.

The effect of the parasite on the internal genital organs is slight, as compared with the effect of *Sacculina* on *Inachus*, and leads to a reduction in the size of the ovaries to about a quarter the normal size, while the testes are usually unaffected. The ovaries of stylopized bees never produce ripe ova, but the testes generally produce normal ripe spermatozoa. The effect on the secondary sexual characters is again slight as compared with that of *Sacculina* on *Inachus*. The external gonapophyses are usually unaltered, or they may be slightly reduced in size: the antennæ are unaltered. The scopa of the parasitized female is generally reduced in size, and she never or very rarely collects any pollen. The punctuation on the abdomen of the male may be increased.

The most striking effect occurs in certain species (e.g. *Andrena labialis* and *A. chrysosceles*) in which the male normally has a yellow clypeus and the female a black one. Stylopization in those cases may lead to the female assuming a yellow clypeus as in the male, while the male may lose the yellow and acquire a partially black clypeus. This acquisition of the yellow clypeus by the female is the only change which can undoubtedly be interpreted as a positive acquisition of a secondary sexual character proper to the opposite sex. This effect may be brought about by male or female *Stylops* indifferently, the sex of the parasite having nothing to do with the nature of the effect exerted.

The effects of stylopization may be ascribed to a merely quantitative abstraction of nutriment from the gonad, leading to its partial atrophy, and not to a qualitative alteration of the metabolism such as is brought about by *Sacculina*. This also applies to the assumption of the yellow clypeus by stylopized females, or the analogy of the assumption of male plumage by many female birds as the result of simple ovariotomy or ovarian atrophy.

Chromosome Complex of Culex pipiens.*—Monica Taylor finds that the somatic number of chromosomes in the gnat is three, in both sexes. The number of chromosomes in the spermatogonia as well as in the primary and secondary spermatocytes and spermatids is three. The spermatogonial cells are not characterized by a synizesis stage. A synizesis stage marks off the spermatogonial from the first spermatocyte stage. The nuclear membrane persists throughout mitosis. The synizesis stage represents an inactive phase of the nucleus in spermatogenesis. A synizesis stage occurs in somatic nuclei.

Narcissus Flies.†—Of the various animal pests attacking the bulbs of Narcissus and related plants none are more injurious than the flies—*Merodon equestris* and *Eumerus strigatus*, known as the large and the small Narcissus fly. The first is like a hive-bee or drone-fly (*Eristalis*). The eggs are laid near the base of the leaves or on the necks of the bulbs;

* Quart. Journ. Micr. Sci., lx. (1914) pp. 377–98 (2 pls. and 3 figs.).
† Board of Agriculture Leaflet No. 286 (1914) pp. 1–6 (1 pl.).

the larvæ feed inside the bulb and may migrate from one to another. The second pest is a small black insect which is supposed to lay its eggs near the base of the leaves. The larvæ burrow into the bulb and destroy the whole interior. But the life-history has not been completely traced.

Bristles of Greenbottle Fly.*—Phineas W. Whiting has made a study of variation and heredity in regard to the number of bristles in *Lucilia sericata* Meig. He deals with a dozen dorsal bristles—posterior dorsocentrals and acrostichals. He reaches two general conclusions: (1) that reduction in bristles tends to affect the males more than the females, while additional bristles are found more often in the females; and (2) that distribution as well as number of bristles is hereditary. Of the 5367 flies bred, 2708 are males and 2659 are females, giving practical equality. Reduction in the males is 748·5 bristles, while in the females it is only 455·5 bristles. Reduction rarely goes beyond the loss of two bristles in a single fly. There are 210 bristles added in the males, while there are 343 added in the females. Thus addition affects the females more than the males. No distinction is made between bristles of large and bristles of small size.

Larva and Pupa of Frit-fly.†—T. R. Hewitt fills a gap in giving a description of these stages in *Oscinis frit*, one of the worst cereal pests in Europe. The maggot is about 3 mm. in length and 0·3 mm. in thickness. It has eleven segments. The head bears two one-jointed papillæ or feelers, two slight thickenings with spines probably sensory, and hook-like spines dorsally. The mouth shows mouth-hooks or "mandibles," and there is a cephalo-pharyngeal skeleton with several paired sclerites in the mouth and gullet. At the posterior margin of the foremost body segment are situated the anterior spiracles with a fine sieve-like opening. The large tail-segment bears posteriorly the hind pair of spiracles on prominent backward-projecting spiracles. The spiracular opening is bounded by a thick chitinous ring. The adjacent cuticle has four very peculiar sets of radiating thickened ridges, situated between openings of the spiracular branches, and they probably serve as a protection to the spiracles, admitting air and excluding foreign material when the spiracles are retracted. The anus is at the end of the minute anal segment, which projects ventrally from the spiracular segment. There is a semicircular anal pro-leg at each side of the median slit. The puparium is red-brown, about 2·5 mm. in length and 1 mm. in breadth. The posterior spiracles are prominent, and the larval mouth-hooks can be seen. The outline of the developing fly, with the contour of the body, and the beginnings of the wings and legs, can be seen in the cleared specimen.

Gametogenesis in Hybrid Moths.‡—J. W. H. Harrison and L. Doncaster have studied hybrid Bistoninæ and their gametogenesis.

* Amer. Nat., xlviii. (1914) pp. 339–55.
† Sci. Proc. R. Dublin Soc., xiv. (3914) pp. 313–16 (1 pl.).
‡ Journ. Genetics, iii. (1914) pp. 229–48 (2 pls.).

Harrison gives a general account of the hybrids he has produced, some with pure species as parents (primary hybrids), and some with either of the two parents a primary hybrid (secondary hybrids). Thus *Lycia hirtaria* ♂ × *Pœcilopsis pomonaria* ♀ gives a primary hybrid, *L. hybr. pilzii*; while *Pœcilopsis pomonaria* ♂ × *L. hybr. pilzii* ♀ gives a secondary hybrid *P. hybr. brooksi*. One tertiary hybrid has been obtained.

Harrison calls attention to a number of interesting points, such as the great constitutional strength of the larvæ and the growing sterility of the primary hybrids as the specific divergence between the parents increases. The "strength" behaves as a Mendelian dominant, and, granting the possibility of aberrations (mutations) possessing great constitutional strength, these two factors alone would result, in some cases, in what could only be classed as new species.

Characters derived from the undoubtedly weaker Ithysiæ may be dominant, which may be due to the primitiveness of the genus. The male parent has almost always the superior influence in the hybridization. No reasonable explanation of this fact has ever been suggested. Four of the hybrids exist only in the male sex under normal conditions; five of the hybrids have the two sexes in approximately equal numbers; three of the hybrids have a large excess of females. The only form reared from a hybrid female (*Lycia hybr. pilzii*), namely *Pœcilopsis hybr. brooksi*, was represented by specimens which were hopelessly gynandromorphic, wings, body, genitalia, antennæ being built up of parts chosen at random, as it were, from both sexes of the parents and grand-parents It is worthy of note that the larger and more robust the specimen, the more the male characters predominate, and *vice versa*. The hybrids have a tendency to emerge long before the parent species. The hybrid females, when produced, vary greatly in their wing development.

Doncaster draws some general conclusions from his observations on the gametogenesis. There are 28 somatic chromosomes in *Lycia hirtaria*, giving 13 in the spermatocytes, one of the thirteen being a large one united to a small one. In *Ithysia zonaria* there are 112 somatic and 56 spermatocyte chromosomes, which are much smaller than most of those of *Lycia hirtaria*. The spermatogonial number of the hybrids, whichever way the cross is made, is as nearly as can be counted 70, of which fourteen are conspicuously larger. Of these fourteen, twelve are derived from the *L. hirtaria* parent and the other two from the *Ithysia zonaria* parent. The early synapsis stage of the spireme in the young spermatocytes and oocytes of the hybrids does not differ greatly from that of the pure species, but it is apparently not followed by a normal pachytene ("bouquet") stage with thick coiled thread. Comparatively few of the chromosomes are paired in the spermatocyte divisions, so that these have only from 5 to 15 fewer than the somatic number.

Noteworthy is the difference in the chromosome number in nearly related species. Since there are exactly four times as many chromosomes in *I. zonaria* as in *Lycia hirtaria*, and since the *Ithysia zonaria* chromosomes are so much smaller that the total amount of chromatin, as judged by the size of the resting nuclei, is approximately equal in the two species, it seems a fair inference to suppose that the *Lycia hirtaria*

chromosomes may be regarded as compound, made up of units corresponding with the separate chromosomes of *Ithysia zonaria*.

Another aspect of the individuality question is touched by the phenomena of the maturation divisions of the hybrids. Although the majority of the chromosomes fail to pair in synapsis, it is certain that some of them do so. Perhaps the chromosomes are not individuals in the sense of being indivisible units, but are composed of units, and perhaps the pairing in synapsis is due to some affinity between chromosomes made up of similar components. If there is any truth in this view, it may give some clue to the baffling problem of interspecific sterility. The *hirtaria-zonaria* hybrids are completely sterile. If the haploid set of 56 chromosomes of *zonaria* consists on the whole of the same units as the 14 haploid chromosomes of *hirtaria*, combined in different ways, the sterility between the two nearly allied species may have arisen simply from a difference of grouping. Since the units are grouped differently, the chromosomes cannot pair properly in synapsis, and this may be the cause of the sterility. Doncaster also discusses the possible cause of the fact that only males are produced from the cross *zonaria* ♀ and *hirtaria* ♂.

Variability of Tiger Moth.*—Kurt Smollian has made a careful study of the variability of *Arctia caja*, the garden tiger-moth. There is almost no variability in shape. Changes in the shape of the wings are associated with changes in venation, and these are almost exclusively pathological. The males are on an average smaller than the females, and their range of variation in size is less. The greater the inhibition in development, the smaller the imago. Inhibitions of growth are due to extremes in the conditions of life, e.g. too high or too low temperature, too much or two little humidity, insufficient or unsuitable food, and insufficient light. Influences which increase the vital activity of the larval and pupal stages increase the size of the imago.

As to colorations and markings, variants induced by frost and great heat are individual aberrations. Those induced by low temperature but not frost, are mostly reversionary, especially as regards the posterior wings. Those induced by warmth, but not great heat, correspond to local southern races. Frost and great heat induce discontinuous variations; less extreme temperatures induce fluctuations. Modifications of the caterpillar do not as such pass on to the imago. The females are more susceptible than the males. There is evidence of a supero-inferior direction of development in the fore-wings, of an infero-superior direction in the hind-wings, and of an antero-posterior development in both. Each character varies *per se* in its own direction. There is a well-marked correlation between the coloration of the thorax and that of the anterior wings, between that of the abdomen and that of the posterior wings. The coloration of the imago is ontogenetically quite independent of that of the larva.

The scales of the posterior wings are broader and have sharper processes than those on the anterior wings, and have more hairlike structures on the root area. These characters are ontogenetically (and

* Jen. Zeitschr. Naturw., l. (1913) pp. 411–600 (6 pls. and 64 figs).

probably phylogenetically) younger. The scales of the anterior and posterior wings show an antero-posterior development. The scales on the thorax and anterior wings hint at a supero-inferior direction of development; the reverse is seen in the abdomen and posterior wings. The females are more variable than the males, with larger scales, more densely granulated, with more ridges. By frost and great heat an inhibition is brought about, the internal pressure is lessened, and the scales are smaller. Cold without frost is followed by smaller and narrower scales, and the differentiation between basal scales and covering scales disappears. This is a return to a more primitive condition. Warmth without great heat is followed by larger scales in consequence of increased metabolism and hæmolymph pressure. Conclusions that apply to characters of wings and body apply also to the scales thereof.

The male and female copulatory organs are fundamentally identical, but specialized in different directions. They hardly vary in *Arctia caja* or in species which are not split up into geographical races. The only variability is in the bristles and spines, and this does not affect copulation. The invariability of the copulatory apparatus helps to fix specific characters.

The number of pinnæ on the antennæ is variable. On an average there are 68 for the male, 64 for the female. Increased temperature reduces the number of joints, decreased temperature thickens and strengthens them. The distribution and number of sensillæ differ in the two sexes. Great heat and probably frost may inhibit the full development of the sense organs. Moderately decreased temperature induces coarser more massive forms (perhaps more primitive). Moderate warmth favours increase in the number of sensory structures. Frost and great heat are unfavourable to the formation of chitin, but moderate raising and lowering of the temperature are favourable.

There are correlations between size and sex, between the coloration of the thorax and that of the anterior wings, between the coloration of abdomen and that of the posterior wings, and between the venation and the marking, but no other correlations could be established.

In the pupa of one day all the parts except the wings show their general structure. The development of hairs, setæ, spines, and the like is very slow till about the nineteenth day. The first dress of the *Arctia caja* as regards wing-form, coloration, setæ, scales, etc., is also phylogenetically the most primitive. The posterior wings show this most clearly.

The range of colour variation in *Arctia caja* is enormous, some tending to be lighter, some to be darker. The males tend to one pole, the females to the other. The species is "hyper-sensitive" to influences during the pro-imaginal period. Selection works only on the general aspect, the anterior wings being protective and the posterior wings repellent. There is no evidence of orthogenesis in Eimer's sense.

Mimicry in Genus Limenitis.*—James Francis Abbott discusses the well known mimicry between *Limenitis archippus* (a butterfly universally distributed in America) and *Anosia* (*Danaida*) *plexippus*,

* Washington Univ. Studies, i. (1914) pp. 203–21 (1 pl. and 2 figs.).

its model. Poulton has pointed out the colour-markings common to non-mimicking and mimicking species of the genus *Limenitis*, and has indicated the changes by which the latter may have been derived from the former by selection. Abbott has tested this view, and decides against it. The colour markings of *Limenitis arthemis*, from which *L. archippus* is supposed to have been derived, display a marked degree of variability, those markings involved in the Poulton hypothesis much less so, however, than the blues and other colours not considered in that theory. According to that theory the influence of selection should be manifest in marked emphasis (or percentage of occurrence) on those markings that incline towards the type of *Anosia*, the model. This Abbott finds not to be the case. The curves for all the characters involved are exceptionally symmetrical, and the skewness is so insignificant that the curves may be treated as normal, indicating that in the individuals studied, no selection with reference to the mimetic colours has taken place.

Life-history of Agriades thersites.—T. A. Chapman * gives an account of the eggs, larvæ, and pupæ of this butterfly. He gives fine photograghs showing the minute structure of the skin at various parts and in various stages, the hairs, the honey-gland region, the cremastral area of the pupa, and the "pockets" of the pupa. In another paper † he describes a new form of seasonal dimorphism in the same species.

Genital Armature in Lepidoptera.‡—G. T. Bethune-Baker brings forward evidence to show that the male genital armature affords valuable guidance in taxonomy and phylogeny. Its characters are reliable in the discrimination of genera as well as of species. Instances are given from the Lycænidæ in particular, but also from the Nymphalidæ and other families.

Heredity of Melanism in Lepidoptera.§—W. Bowater concludes that the weight of evidence up to the present seems to show that melanism in Lepidoptera frequently follows the Mendelian law of heredity, and in most cases is dominant, but in some few species is recessive.

Sense-organs of Dytiscus Wings.‖—Richard Lehr describes the various groups of cupola-like sense-organs at the base of the anterior wings and the chordotonal organ in the subcostal vein, giving a detailed account of the minute structure. Besides the sensory organs at the base there are sensory setæ on other parts, especially near the anterior margin, which are tactile in function. Passing to the elytra, Lehr describes its cupola-like organs, hollow cones, and sensory setæ, distinguishing three kinds of the latter. All the sensory structures on

* Trans. Entomol. Soc., 1914, pp. 285–308 (28 pls.).
† Trans. Entomol. Soc., 1914, pp. 309–13 (1 pl.).
‡ Trans. Entomol. Soc., 1914, pt. 2, pp. 314–37 (11 pls.).
§ Journ. Genetics, iii. (1914) pp. 299–315 (1 pl.).
‖ Zeitschr. wiss. Zool., cx. (1914) pp. 87–150 (45 figs.).

the elytra pertain to the mechanical sense. A scheme is given showing the distribution of the various structures on the alæ and elytra, and the minute structure is copiously illustrated.

Mechanism of Flight in Lamellicorns.*—Fr. Stellwaag has made a very careful study of the detailed adaptations of the meso- and metathorax, the elytra and the wings in relation to flight. He discusses, for instance, the way in which the elytra are moved into their position during flight and "locked" (serving for steadying), and how in their resting position they are adapted to give the wings the most effective protection.

Scent-organs in Caddis-flies.†—Bruce F. Cummings calls attention to the enormous development of the palpi of the first pair of maxillæ in the male of *Sericostoma personatum*, a tolerably common caddis-fly in Britain. Unlike the maxillary palpi of the female, which are five-jointed and quite normal, those of the male consist of but a single segment very much enlarged and shaped like a half-moon. These two palpi are placed together and held vertically so as to mask the front of the head. They have received various interpretations, but appear to be definitely odoriferous.

Scent-organs secreting an attractive odour and confined to the male are known in various Lepidoptera, Coleoptera, and Blattidæ, and the case of *Sericostoma personatum* should be added to the list. Scent-organs are usually on the abdomen or on the thoracic appendages; their position on the palpi of *Sericostoma* is unique save for the case of an Indian butterfly, *Bertula chalybialis*, where well-developed and characteristic scent-organs occur on the labial palpi.

The author describes the detailed structure of the mouth-parts in *Sericostoma personatum*, with particular reference to the maxillary palpi. He gives a histological account of the scent-organ, which consists of two sacs and a septum between them, glandular epithelium and scent-hairs rooted in it.

Tertiary Thysanopteron.‡—R. S. Bagnall describes *Stenurothrips succineus* g. et sp. n. from Baltic amber. It shows affinities with the neotropical genus *Heterothrips*, and is referred to the family Heterothripidæ. A very remarkable feature is that the tenth abdominal segment is abnormally produced, and is open ventrally for its entire length. It is longer than the head and prothorax taken together. Bagnall has observed a similar tube-like extension in several forms, notably in *Panchætothrips*.

Gastric Cæca of Heteroptera.§—H. Glasgow discusses the cæca at the end of the mid-gut in numerous bugs. The cæca contain masses of bacteria of various kinds, "morphologically characteristic for the

* Zeitschr. wiss. Zool., cviii. (1914) pp. 359–429 (5 pls. and 15 figs.).

† Proc. Zool. Soc., 1914, pp. 459–74 (8 figs.).

‡ Geol. Mag., No. 605 (1914) pp. 483–5 (1 pl.).

§ Biol. Bull., xxvi. (1914) pp. 101–70. See Trans. Amer. Micr. Soc., xxxiii. (1914) pp. 144–5.

particular species harbouring them." It looks as if the caecal bacteria were antagonistic to intruding bacteria. The caeca differ greatly in different types; they show a gradation from simple to complex forms; they may be indices of relationship.

Suction in Potato Capsid Bug.*—P. R. Awati has made a thorough study of the mechanism of suction in *Lygus pabulinus*. He deals with the mouth-parts and their homologies, the structure of the head, the tentorium, the muscles of the head, the pharynx, gustatory organs, and pumping apparatus which forces the salivary secretion forward into the efferent salivary duct and thence into the ejection-canal of the maxillary stylets. In sucking, the first step is to apply the proboscis to a suitable part of the leaf. The stylets are then driven forwards, being pushed down by the bending of the proboscis. When the stylets reach particular tissues, the maxillo-mandibular muscles begin to act, and the mandibles get fixed into the cellular walls by means of their recurved hooks. Saliva is injected into the wound and probably affects the sap. There is capillarity in the suction-canal and this is helped by the turgidity of the cells. In the pharynx there are two complementary factors which force the sap onwards towards the œsophagus: (1) a vacuum is produced by the raising of the operculum, and (2) the elasticity of the operculum enables it to regain its normal position. A peristalsis is produced in the œsophagus by means of constrictors, and a valvular action prevents the sap from flowing back into the œsophagus from the stomach.

Injurious Insects in Ireland.†—G. H. Carpenter deals with the frit-fly, larvæ of a species of black-fly (*Bibio*) eating into potato-tubers, the migratory Apple aphid (*Aphis fitchii*), the Furze mealy-bug (*Pseudococcus aceris*) from apple shoots, various spring-tails (*Achorutes armatus* and *Lipura armata*), the fern scale-insect (*Chionaspis aspidistræ*) from filmy ferns, and many other forms. He reports the interesting occurrence of the ox warble-maggot (*Hypoderma bovis*) from the back of a horse.

Braconid Parasite of Pine-weevil.‡—J. W. Munro has found parasitic larvæ attacking the larvæ of *Hylobius abietis*, and has identified them with *Bracon hylobii* Ratzeburg. They may be of value in combating the attacks of the pine-weevil, which are becoming more and more common in Britain. It is a hardy parasite, apparently without hyperparasites, and it attacks the weevil larva in its resting stage.

Life-history of Belladonna Leaf-miner.§—A. E. Cameron describes the various stages of *Pegomyia hyoscyami*—egg, larva, and puparium, and deals also with the copulation, oviposition, and the embryonic period. Special attention is paid to the buccal-pharyngeal apparatus and to practical questions. The maggot devours the parenchyma of

* Proc. Zool. Soc., 1914, pp. 685–733 (29 figs.).
† Econ. Proc. R. Dublin Soc., ii. (1914) pp. 142–60 (1 pl. and 8 figs.).
‡ Ann. Applied Biol., i. (1914) pp. 170–6 (4 figs.).
§ Ann. Applied Biol., i. (1914) pp. 43–76 (2 pls.).

the leaves of belladonna, mangolds, beet, and henbane. It causes a blistered appearance on the leaves and they soon wither. Hibernation occurs in the pupal condition about two inches below the surface of the soil. The eggs are laid superficially on the back of the leaf in groups of parallel rows. The incubation period is about five days. The larvæ feed uninterruptedly and complete their metamorphosis in about 10 days. The average period for a complete life-cycle is about 36 days. There may be three broods in the season. Two closely related species, *P. bicolor* and *P. nigritarsis* attack common weeds like the dock, and their life-histories resemble those of *P. hyoscyami*. Experiments showed that mangold-reared adults would not oviposit on belladonna, and *vice versa*. Some natural control is secured by the parasitism of two species of Braconids, on one or both of which a Proctotrypid is probably hyper-parasitic.

δ. Arachnida.

Nests of Pseudoscorpions.*—H. Wallis Kew has made a careful study of these interesting structures. They are made in part or wholly from silk produced by the pseudoscorpions, which enclose themselves in the nests for moulting, for brood purposes, and in some cases for hibernation. Such nests are closed cells of spun-tissue with or without an external covering of extraneous materials. The internal spun-tissue is thick and dense, almost like silk-paper. It is composed of innumerable threads crossed and re-crossed, and coalesced in irregular confusion and without interspaces.

The material is secreted by glands in the cephalothorax whose ducts traverse the cheliceræ and open at the tips of the branches of the galea, or on or near the margin of a tubercle which replaces that structure in some groups. Spinning is done with the cheliceræ, the animal gradually imprisoning itself. The construction of an external framework is the first part of the task, silk threads forming an open irregular mesh-work to which extraneous material is usually attached.

The silk is drawn from the galea or tubercle in several separate viscid very fine threads, which remain separate or coalesce, all those from each galea or tubercle sometimes forming a single thread. In spinning there are continuous forward and backward movments of the body and lateral movements of the cheliceræ.

During the earlier parts of the work, when attachments are being made from place to place, the threads usually coalesce, and since they fuse at once, either before or after coalescing with other threads or objects, the irregular mesh-work soon results. Afterwards the animal settles down to long-continued spinning, and silk is rapidly brushed on to the interior, first in one place and then in another. The threads now usually fuse separately, being applied in more or less parallel series of several side by side; and when both galeæ or tubercles are used together, ten or twelve threads may be deposited at a time. The animal continues thus to work at intervals for days or even weeks, till the final dense tissue is at last produced over every part of the interior

* Proc. Zool. Soc., 1914, pp. 93–111.

of the nest. The methods of three species, *Chelifer cyrneus*, *C. latreillii*, and *Obisium muscorum*, were observed in detail. They were essentially identical and probably characteristic of all Pseudoscorpiones.

ε. Crustacea.

Inheritance in Parthenogenesis.* —W. E. Agar has made important observations on inheritance in three Cladocera, *Simocephalus exspinosus*, *S. vetulus*, *Daphnia obtusa*, and *Macrosiphon antherinii* an Aphid. Where it is necessary to express the group of individuals descended asexually (in Agar's cases parthenogenetically) from a single ancestor, Shull's word "clone" is used. When the population is known to have been descended asexually from a single common ancestor, it consists of a single clone and may be called monclonal. When it is composed of a number of clones each descended from an original ancestor not asexually connected with the original ancestors of the other clones, the population may be called polyclonal.

The general result of the experiments with Cladocera was to show a genetic identity between parent and offspring. In the experiment with the Aphid there was a hint of a partial inheritance of individual variations, but it was found that this resemblance was probably not due to inheritance proper. No mutation was observed in the Cladocera. Conspicuous variations when they occurred were tested by breeding, and found to show no trace of inheritance. Such variations must therefore be regarded as purely somatic modifications. Purely somatic fluctuation is increased by subjection to abnormal conditions.

Parthenogenetic and Sexual Reproduction in Cladocera.* W. E. Agar publishes a paper which presents some new experimental evidence, and points out some general indications that the change from parthenogenetic to sexual reproduction, and the degeneration which so often accompanies it, is determined by environment only, and that the number of preceding parthenogenetic generations, or the lapse of time since the last sexual act are not, as such, relevant to the matter at all. His conclusions refer mainly to *Simocephalus vetulus*, but may probably be safely extended to a wide range of the Cladocera. They are as follows:—Certain not yet fully elucidated factors in the environment influence the onset of sexuality. Certain factors likewise bring about "degeneration," or high rate of mortality. Certain factors of the environment may act cumulatively over a number of generations. Therefore the increasing sexuality and "degeneration" (or high mortality) observed under certain supposedly constant experimental conditions receive a ready explanation in the supposition that the environment is one favourable to the development of these phenomena. This explanation is made much more probable when we find that under other experimental conditions there is no tendency to increasing sexuality or degeneration. Many species exhibit the phenomenon of specially labile periods, when sexuality is

* Phil. Trans., Series B, ccv. (1914) pp. 421-89.
† Journ. Genetics, iii. (1914) pp. 178-94.

easily influenced by certain factors of the environment. This labile condition is usually ascribed to the fact that the line is in about the middle of the reproductive cycle, the diminishing tendency to parthenogenesis being about equally balanced by the increasing tendency to sexual reproduction. Such a balanced condition must, however, be passed through, whether the tendency to sexuality is being increased by the progress of the "cycle," or by the cumulative effect of an unfavourable environment. Hence, the existence of labile periods is as readily explained on the one hypothesis as on the other. There is no justification for retaining the hypothesis of an inherent reproductive cycle, that is to say, the hypothesis that the number of generations or lapse of time since the last fertilized egg influences, as such, the production of sexual or degenerate forms. For the production of these forms is under certain conditions not influenced even by the lapse of an enormous number of parthenogenetic generations, while their production certainly is influenced by environment in other cases. The residuum of cases being equally well explicable on either hypothesis (cycle or environment) it is most reasonable to suppose that the factor that was effective in the one case was the one that was effective in the other, and, conversely, that the ineffective factor of the one case ("reproductive cycle") was ineffective in the other.

Fresh-water Prawns from Tonkin.*—E. Solland describes *Leander mani* sp. n. and *Coutierella tonkinensis* g. et sp. n. The latter is one of a number of small isolated fresh-water genera, such as *Allocaris*, *Desmocaris*, and *Pseudopalæmon*, oftenest with a single species, with large ova and condensed development, and with a strange mixture of ancestral and specialized characters. The structure of the maxilla in *Coutierella* is very distinctive. In both types the eggs are large and relatively few, and the development is condensed. The first larval form has all its pereiopods and pleopods, and has even its uropods visible in a rudimentary stage beneath the skin.

New Barnacles.†—Nelson Annandale describes some new and interesting pedunculate Cirripedes from Indian seas. The collection includes *Alepas investigatoris* sp. n. with translucent tissues, white except the yellowish cement glands, found like other members of the genus on the umbrella of a pelagic medusa. Another new form, *Heteralepas* (*Paralepas*) *reticulata* sp. n., is a very small animal, found on spines of Cidarid sea-urchins. The external appearance is very distinctive: the capitulum is almost globular; there is no carinal crest, but the posterior part and the sides are covered with a reticulation of deep grooves, and in the centre of each mesh there is a projecting tubercle. Below the aperture the surface is smooth or marked with irregular (mostly transverse) grooves. No scuta can be distinguished, but the outline of a pair of irregular areas is sometimes indicated on the smooth anterior part of the capitulum, in the position the scuta would occupy.

* Bull. Soc. Zool. France, xxxix. (1914) pp. 314–24 (4 figs.).
† Records Indian Museum, x. (1914) pp. 273–320 (2 pls.).

Ostracod from Middle Devonian.*—Frederick Chapman describes *Primitia yassensis* sp. n., based on an isolated specimen from the Middle Devonian of New South Wales. It is nearly allied to *P. scaphoides* Rupt. Jones, and belongs to the group of which *P. mundula* (Upper Silurian to Lower Devonian) is the central type. He also describes a patch of ostracodal limestone from the same district, showing that several other genera besides *Primitia* are probably present in the Middle Devonian limestone of Australia.

Annulata.

Parasitic Eunicid.†—M. Caullery describes *Labidognathus parasiticus* g. et sp. n., a Eunicid Polychæte of parasitic habit. A few cases of Polychætes inside other Polychætes have been previously recorded: *Lombriconereis* (?) in *Marphysa sanguinea*, *Oligognathus bonelliæ* in *Bonellia*, *Hæmatocleptes terebellidis* in *Terebellides strömi*, *Labrorostratus parasiticus* in various Syllids, *Oligognathus parasiticus* in *Spio mecznikovianus*, all showing some retrogressive characters, e.g. as regards jaws, parapodia, pigment, mucous glands of the ectoderm. Caullery's new instance was found in a Terebellid from near Timor. The parasite was probably in a peri-intestinal blood-sinus: it had over a hundred segments. The prostomium is without eyes or appendages; the same is true of the buccal and the succeeding segment. From the second metastomial segment onwards there are slightly developed parapodia. The maxillary apparatus is of the Eunicid type, but slightly reduced.

Species of Pristina.‡—H. E. Hayden, jun. describes three new species of Naiads in the genus *Pristina* from Virginia and Texas. They were found in ponds and aquaria along with species of *Dero* and other fresh-water Oligochæts. One of the new forms, *Pristina antenniseta*, was remarkable in showing well-developed gonads at a time when the animal was actively engaged in the process of fission.

British Leeches.§—L. A. L. King gives a welcome list of leeches found in the Glasgow district. The Rhynchobdellidæ included *Trachelobdella* sp. from *Acanthias vulgaris*; *Pontobdella muricata* from skates; and three from fresh water—*Protoclepsis tessellata* ("large gelatinous-looking leeches, translucent, greyish green," sometimes flecked with pigment, sometimes almost transparent, feeding on water-fowl); *Glossosiphonia tuberculata*; and *Helobdella stagnalis*. The Arhynchobdellidæ included *Hæmopis sanguisuga* and *Herpobdella octoculata* both common in Possil Marsh. Without any systematic search, six, or possibly seven, of the thirteen known British species were found around Glasgow and the Clyde Sea area.

* Journ. R. Soc. N.S. Wales, xlvii. (1914) pp. 244-7 (1 pl.).
† C.R. Soc. Biol. Paris, lxxvii. (1914) pp. 490-3 (4 figs.).
‡ Trans. Amer. Micr. Soc., xxxiii. (1914) pp. 135-8.
§ Glasgow Naturalist, vi. (1914) pp. 39-47.

Nematohelminthes.

North American Fresh-water Nematodes.*—N. A. Cobb has done a useful piece of work in giving an account of the North American free-living fresh-water Nematodes. Apart from his own previous investigations he has had an almost unworked field, and many new forms have been discovered. He deals with 28 species, but no doubt there is a horde of species awaiting discovery in North American waters. As in former papers, he makes much use of measurements of the worm viewed in profile: the first from the anterior end to the base of the pharynx, the second to the nerve-ring, the third to the "cardiac constriction" or end of the neck, the fourth to the vulva in females and to the middle of the body in males, and the fifth to the anus.

Classification of Strongylidæ.†—M. Neven-Lemaire discusses the proposal of Railliet and Henry to divide the genus *Nematodirus* into two sub-genera — *Nematodirus* with the type *Strongylus filicollis* (Rudolphi, 1802), and *Mecistocirrus* with the type *Strongylus digitatus* von Linstow, 1906. The author gives a good figure of the female genital system in the two types, and shows that the sub-genera must be regarded as genera. In *Nematodirus filicollis* the vulva is towards the posterior third of the body; the vagina is very short; the ovijectors are well-developed; one of the uteri runs posteriorly, the other anteriorly; there are only a few large ova, their diameter equals that of the uterus: the ovaries are short, the anterior one extending towards the head, the posterior one extending first backwards to the tail and then forwards. In *Mecistocirrus digitatus* the vulva is posterior, a little in front of the anus: the vagina is very long: the ovijectors are slightly developed: the two uteri are side by side, extending anteriorly, and containing a considerable number of ova, small in proportion to the dimension of the animal; the ovaries are long and parallel, and describe circumvolutions around the alimentary canal.

Ankylostomiasis in Dogs.‡—W. Nicoll finds that the hook-worm anæmia of dogs differs from that of man inasmuch as only young animals suffer greatly, and the progress of the disease to a fatal termination is very rapid. Older dogs are infected only to a moderate extent, there is a minor degree of anæmia, and there is gradual recovery. The anæmia in young dogs is characterized by great loss of weight, emaciation, prostration, and intestinal hæmorrhage. The blood volume of dogs suffering from the minor degree of hook-worm anæmia is not materially altered, but if anything is somewhat diminished. The oxygen capacity of the blood per unit of body-weight is also, on the average, somewhat decreased. Infection is generally accompanied by distinct though not profuse hæmorrhage, which is most marked in the early stages, but tends to disappear. Eosinophilia was not a constant sign either of

* Trans. Amer. Micr. Soc., xxxiii. (1914) pp. 69–119 (7 pls.).
† Bull. Soc. Zool. France, xxxix. (1914) pp. 293–6 (2 figs.).
‡ Journ. Hygiene, xiii. (1914) pp. 369–92.

infection or of disease. Evidence of blood-regeneration was furnished by the appearance of large numbers of erythroblasts (normoblasts) which increased with the progress of the disease. Cats are much less easily infected than dogs, and monkeys are altogether insusceptible. Man, also was found to be insusceptible to infection with dog hook-worm.

Nematode Cyst in Alligator's Stomach.*—A. M. Reese describes and figures a cyst of an immature *Ascaris tenuicollis*, 75 mm. in length, found as a swelling on the outside of the stomach of an eighteen inch Florida alligator.

Platyhelminthes.

New Genus of Avian Cestodes.†—H. A. Baylis describes *Octopetalum gutteræ* sp. n. from the intestines of a guinea-fowl (*Guttera edouardi*) from Nyasaland. The scolex is unarmed, without rostellum, but with a slight conical papilla at the apex. The suckers are completely covered by overhanging epaulette-shaped appendages of their anterior borders, each of these appendages having a marked median cleft extending for some distance from its free edge. The neck is very short. The segments are anteriorly much broader than long: the posterior segments are about three times as long as broad, the last being the largest and narrowest. A single pair of lateral excretory vessels is present throughout the strobila, connected in each segment by a transverse vessel. There is a single set of reproductive organs in each segment. The genital pores are irregularly alternate. The vagina opens behind the cirrus-sac, in the same horizontal plane. A paruterine organ is developed in front of the uterus in the gravid segments. The yolk-gland is dorsal to the ovary. The eggs have three transparent envelopes. In the "auricular appendages" of the suckers and in external appearance the new genus resembles *Tetrabothrius*: in the possession of a paruterine organ it approaches more nearly to the Idiogeninæ among the Davaineidæ, or to the Paruterininæ among the Hymenolepidæ.

Studies on Cestodes.‡—F. E. Beddard describes *Rhabdometra cylindrica* sp. n. from an African partridge. It is a long slender form, about a millimetre in diameter. He also discusses the structure of *Otiditænia eupodotidis* with especial reference to the hint of the beginning of a paruterine organ. There is an alteration of structure in the whole medullary layer in the direction of increased firmness; but there is no special part of that parenchyma set apart for the sheltering of the growing embryos. In genera like *Oochoristica* and *Linstowia* the ripe embryos lie in the unaltered parenchyma. A slight increase of specialization of the conditions observable in *Otiditænia* leads at once to such a form as *Sphyroncotænia* where a large conical paruterine organ exists, which is distinct from the surrounding medullary parenchyma.

* Trans. Amer. Micr. Soc., xxxiii. (1914) p. 138 (1 pl.).
† Ann. Nat. Hist., xiv. (1914) pp. 414–20 (2 pls.).
‡ Proc. Zool. Soc., 1914, pp. 859–87 (11 figs.).

Trematodes of North Queensland.*—W. Nicoll establishes two new genera, *Dolichopera* from a carpet-snake and *Aptorchis* from a turtle, both referred provisionally to the family Lepodermatidæ. In *Dolichopera*, the cuticle is covered with spines; the ventral sucker is smaller than the oral sucker and situated behind the middle of the body; the œsophagus is short, and the diverticula extend to near the posterior end of the body; the genital aperture is between the oral sucker and the margin of the body, on the right or left side: the cirrus-pouch is sinuous and elongated; the ovary is behind the right posterior quadrant of the ventral sucker; the testes are behind the ovary near the posterior end of the body, longitudinally oval and somewhat asymmetrical, the left testis being in advance; the yolk-glands are entirely lateral in the posterior part of the body; the uterus is very voluminous, filling up the whole of the middle of the body, and passing between the testes only for a very short distance. The ova are 0·03 to 0·04 mm. in length, and about 0·02 mm. in breadth.

In *Aptorchis*, the cuticle is beset with moderately large spines: the intestinal diverticula are short; the testes are exactly midway between the ventral sucker and the posterior end of the body; the ovary lies midway between the two surfaces; it is almost median and somewhat oval; the yolk-glands are entirely lateral and extend from a little behind the ventral sucker to the posterior end of the body; the uterus is very voluminous; the numerous ova measure 0·028 to 0·031 mm. by 0·018 to 0·019 mm. The author also describes new species of *Clonorchis*, *Echinostoma*, *Eurytrema*, *Mesocœlium*, *Lepoderma*, *Prosthogonimus*, *Hemistomum*, *Strigea*, and *Tetracotyle*.

Trematode Parasites of Fishes from the English Channel.†—W. Nicoll examined 79 species of fishes (475 specimens) and found 80 p.c. (380) infected with parasitic worms—56 p.c. with Trematodes, 44 p.c. with Cestodes, 48 p.c. with Nematodes, and 2 p.c. with Echinorhynchs. Fifty different species of Trematodes were obtained, about three-fifths of the total number of Trematodes known to occur in British marine fishes. Nicoll describes *Steringotrema pagelli* (Nicoll), *Bacciger bacciger* (Rud., Stoss), *Bucephalus minimus* (Stossich), *Rhipidocotyle minima* (Wagener), *R. viperæ* (van Ben.), *Prosorhynchus triglæ* (?), and other forms.

Incertæ Sedis.

Development of Balanoglossus clavigerus.‡—G. Stiasny traces the development from the egg to the Tornaria, which takes about forty hours. The cleavage is at first total and equal, and of the radial type; inequality sets in at the fourth division. A morula is formed which becomes a cœloblastula. The flattened cells of the vegetative pore are invaginated in gastrulation and the blastopore is shut. From the most anterior part of the archenteron the water-vascular vesicle is constricted

* Parasitology, vi. (1914) pp. 333–50 (2 pls.).
* Journ. Marine Biol. Assoc., x. (1914) pp. 466–505 (6 figs.).
‡ Zeitschr. wiss. Zool., cx. (1914) pp. 36–75 (3 pls. and 24 figs.).

off. The history of the hydrocœl is traced, and the formation of the apical plate and oral invagination. The newly emerged club-shaped larva has very long cilia and a marked heliotropism. The form known as *Tornaria mülleri* is the pelagic stage of *Balanoglossus clavigerus*; it shows no hint of heart or cœlome; it passes into a *Tornaria krohnii* stage. The first pair of cœlomic sacs arise as solid outgrowths on both sides of the posterior gut. An account is given of the structure and development of the apical plate and of the eye.

Echinoderma.

Echinus Hybrids.*—H. M. Fuchs made a cross between *Echinus esculentus* ♀ and *E. acutus* ♂, and successfully reared four of the hybrids. Two of them have laid eggs. Some eggs and sperms were obtained, and the fertilized ova yielded healthy larvæ (F_2 generation). When a larger number of the F_1 hybrids have been reared, an examination of the characters of the fully grown urchins should decide whether the fertile intermediate forms found in the sea are hybrids or extreme variants of one of the two species.

When the ova of *E. miliaris* were fertilized with the sperm of the F_1 hybrid, or when the sperm of *E. miliaris* was used to fertilize the ova of the F_1 hybrid, it was found that *E. esculentus* characters and *E. acutus* characters were developed in both crosses.

The F_2 generation obtained from the *E. esculentus* and *E. acutus* hybrids can give no information as to the inheritance of the late larval characters, since the latter are alike in the two species. It is the F_2 generation from hybrids between *E. esculentus* or *E. acutus* and *E. miliaris* that will give this valuable information; but no forms of this generation have as yet reached maturity.

Development of Common Starfish.†—J. F. Gemmill has studied the development of *Asterias rubens*, the common starfish. The spawning season is from the end of April till the beginning of July. Maturation is in progress while the eggs are being shed. Segmentation is total and equal, or practically equal; the blastula wall is a single layer: the gastrula is formed by invagination; the mesenchyme arises, after gastrulation, from the enlarged blind end of the archenteron.

The gastrula elongates and the blastopore migrates ventralwards; the stomodæal pit and circumoral depression forms near the middle of the ventral surface; the preoral and postoral bands merge at first into an antero-dorsal strongly ciliated area; these bands are next continuous in the auricularia and then divide in the bipinnaria. The typical larval ciliated processes grow out, all relatively long, slender, and freely movable, especially the postero-lateral pair. The brachia have the preoral band continued over them, and have truncated ends bearing six to eight papillæ. The sucker is well-marked with usually two papillæ on each side of it: the posterior part of the larval body becomes disk-like and

* Journ. Marine Biol. Assoc., x. (1914) pp. 464–5.
† Phil. Trans., Ser. B, ccv. (1914) pp. 213–94 (7 pls.).

shows five arm-rudiments in crescentic series. There is an interval (aboral brachiolarian notch) between the antero-dorsal and antero-ventral arm-rudiments (rudiments II and I). Ciliation persists from the blastula stage onwards, but becomes lessened over the general surface. The ciliated bands are locomotor except the transverse portion of the preoral band. The special adoral ciliation consists of the peristomial ring and œsophageal loop, and acts towards the stomach except on a small segment of the peristomial ring. The surface between the preoral and postoral bands is a food-gathering area; the buccal cavity and the first part of the œsophagus can be emptied by a backward flexion of the preoral lobe.

The author describes the internal structure of the larva, and the process of metamorphosis in its external and internal aspects, and directs attention to the following conclusions of morphological or general interest:—

The presence of a rudimentary posterior enterocœlic outgrowth suggests a principle which goes far to reconcile or explain what seemed extremely divergent modes of origin of the enterocœles in starfish and Echinoderms, and in Enteropneusts.

There is morphological equivalence between the epigastric (larval right posterior) cœlom and the hypogastric (larval left posterior) cœlom. In the early larva there is a right middle cœlomic region morphologically equivalent to the region on the left side which gives rise to the hydrocœle, viz. the left middle cœlomic region. No rudiments of the right hydrocœlic region are recognizable after normal metamorphosis.

The separation of the young starfish from its stalk, and certain other considerations, harmonize with the view that the asterid and the crinoid stalks are morphologically equivalent. The dorsal sac is an "epicardial" pulsating sac homologous with the pericardium of *Balanoglossus*. There is detailed morphological and probably also functional correspondence between the hæmal systems of Asterids and Enteropneusts. In particular, the axial organ and pharyngeal cœlom of *Asterias* are homologous respectively with the left pharyngeal vessel and the left pharyngeal cœlom of *Balanoglossus*. A bilateral "starfish" can result from the metamorphosis of a double-hydrocœle brachiolaria.

The rays of a starfish should be numbered according to a scheme which makes the anal inter-radius in part the most anterior and in part the most posterior of the inter-radii. There is evidence of the existence in the late larvæ of a sub-epidermal nervous network and of a system of neuro-muscular fibres. Of all Echinoderm larvæ the brachiolarian type has probably retained the greatest number of primitive characters and acquired the smallest number of secondary characters. New data are given regarding a number of points relating to adult structure and function, e.g. regions and curvature of the alimentary canal, the structure and function of the madreporite, the hæmal system, the cœlomic and perihæmal ciliation, etc.

Studies on Holothuroids.* —Joseph Pearson proposes a re-classification of genera *Mülleria* and *Holothuria*, which have been separated by

* Spolia Zeylanica, ix. (1914) pp. 163–72 (1 pl.).

a single character, namely the presence of anal teeth in the former and the absence of these structures in the latter. He finds reason to unite the genera under the title *Holothuria*, with five sub-genera. Of these the old genus *Holothuria* includes three—*Bohadschia*, *Halodeima*, and *Thymosicya*, and the old genus *Mülleria* two—*Actinopyga* and *Argiodia*. The number and arrangement of the tentacles, Polian vesicles, and stone canals are variable characters even within the limits of a single species. This is also true of the Cuvierian organs. There are only four characters of any taxonomic value in the genus. These are (1) the arrangement of the ambulacral appendages: (2) the nature of the spicules; (3) the presence or absence of anal teeth; and (4) the structure of the calcareous ring. With reference to these—the calcareous ring primarily—Pearson classifies the sub-genera. He also deals with the numerous Indian Ocean species of *Holothuria*,* including two new species, and with the Indian Ocean species of *Argiodia* † and *Actinopyga*. Diagnoses and figures of the calcareous corpuscles are given.

Cœlentera.

New Alcyonarian Genus.‡—S. F. Light describes *Lemnalioides kükenthali* g. et sp. n. from the Philippines. The colony is upright, tree-like, or bushy, and consists of a number of stems coalesced in one or more groups for some distance above the base. The tubular, non-tractile polyps are scattered singly or in little groups on the branches and lateral and terminal twigs. The spiculation of the cortex and the canal walls is similar to that in *Lemnalia*. The tentacles contain a very few very small scattered spicules, and the stomodæum contains no spicules. The tentacles bear more than one row of pinnules and show a median longitudinal band of muscle-fibres on their outer surfaces.

The author emends the diagnosis of the genus *Lemnalia*, from which the new genus then differs in that the tentacles contain very few spicules and the stomadæum none, and in that there is a double row of pinnules on each side of the tentacles. The new genus is intermediate between *Lemnalia* and *Lithophytum*, but is much nearer the former. It differs from *Paralemnalia* most distinctly in its more tree-like colony form, in that the polyps are sometimes arranged in little groups and are borne on the branches and twigs, in the absence of stomodæal spicules, and in the scarcity of spicules in the tentacles. It is suggested that *Paralemnalia*, *Lemnalia*, and *Lemnalioides*, might be ranked as a sub-family Lemnaliinæ within the family Nephthyidæ.

Philippine Scyphomedusæ.§—S. F. Light describes a number of interesting new forms. He establishes a new Rhizostomatous genus *Acromitus*, which is most closely related to *Catostylus*, and less closely to *Lychnorhiza* and *Crambione*. He emends the generic characters of *Lobonema* Mayer, and places near it a new genus *Lobonemoides*.

* Spolia Zeylanica, ix. (1914) pp. 49–101 (10 pls.).
† Spolia Zeylanica, ix. (1914) pp. 173–90.
‡ Philippine Journ. Sci., ix. (1914) pp. 233–45 (1 pl. and 8 figs.).
§ Philippine Journ. Sci., ix. (1914) pp. 195–231 (16 figs.).

Stylasterids.*—Hjalmar Broch deals in a very careful manner with northern Stylasterids: *Pliobothrus symmetricus*; *Stylaster gemmascens* and *Stylaster roseus*, both of which he includes in a new subgenus *Eustylaster*; and *Stylaster norvegicus*, which he refers to the subgenus *Allopora*. The structure of these four forms is discussed and finely illustrated. A consideration of affinities leads him to the conclusion that the Hydrocorallines are two convergent families of Hydroids, marked by their calcareous skeleton and dimorphism. The family Milleporidæ probably had its origin from the Corynidæ and the Stylasteridæ from the Bouganvilliidæ. Broch calls attention to the interesting fact that as in many other Cœlenterates, so in the four northern Stylasterids, the skeleton is formed of Aragonite. As all Aragonite contains magnesium, this means that the animals have the power to make use of the magnesium in the sea water. But why some corals should have aragonite skeletons and others (like *Corallium*, *Tubipora*, *Cystiphyllum*, and *Anabaria*) should have calcite skeletons remains quite obscure.

Hydroids of the Great Australian Bight.†—W. M. Bale describes some new species, e.g. of *Cryptolaria*, *Hypopyxis*, and *Nemertesia*. As in a former report, the Plumularians predominate, and are of interest as including types of *Aglaophenia* and *Halicornaria* not previously known from Australian localities.

Restitution Masses formed by the Dissociated Cells of Hydroids.‡ W. de Morgan and G. H. Drew have made a study of the restitution masses formed by the dissociated cells of the Hydroids *Antennularia ramosa* and *A. antennina* Their results largely bear out those obtained by H. V. Wilson, but the histological structure of the restitution masses differed in many ways from that described by Wilson. The Hydroids were cut in pieces and pressed through bolting silk, with the result that isolated cells and small cell-aggregates were obtained, which soon aggregated together to form compact masses. These restitution masses secreted a perisarc within from 12 to 18 hours. Various changes in shape, and general retraction of the mass away from the perisarc occurred later, but even up to sixty days there was no sign of the regeneration of the hydranths. The restitution masses consisted of ectoderm and endoderm cells, and in addition such structures as nematocysts, ova and broken-down cells, all of which were subsequently absorbed, and played no part in the future development. The ectoderm cells were relatively little damaged, and were embedded in a plasmodial mass formed by the endoderm cells. A definite layer of ectoderm cells is formed on the surface, and these cells secrete the perisarc. Gradual aggregation and segregation of the endoderm cells from the plasmodial mass takes place; and they form very definite tubules, very similar in structure to the cœnosarcal tubules continuous with the enteric cavities of the normal hydranths. These tubules are embedded in a mass of ectoderm cells; they are convoluted and ramify in all directions. Many

* Danish Ingolf Exped., v. (1914) pp. 1–25 (5 pls. and 6 figs.).
† Biol. Results Fishing Experiments Australia, ii. (1914) pp. 166–88 (4 pls.).
‡ Journ. Marine Biol. Assoc., x. (1914) pp. 440–63.

granules develop in the cytoplasm of these cells, and after about a month many of them have degenerated. The ectodermal cells show no signs of degeneration, though the masses containing them have been kept alive for sixty days. In none of the experiments was there any sign of cell-division. The experiments in question resulted in the production of masses that were abnormal and pathological, but the segregation and re-arrangement of the cells after isolation, and the comparatively long duration of life of the tumour-like masses to which they give rise are facts of considerable theoretical interest.

Protozoa.

Amœbæ of Larval Tipula.*—Doris L. MacKinnon suggests that some system of interchange of preparations would almost certainly check the output of unnecessary "new species." Since Schaudinn's work in 1903, the literature dealing with amœbæ has yearly increased, and in following up any particular clue it is becoming a very formidable task to unravel the criss-cross strands of evidence. While a good deal is known of the parasitic amœbæ of Vertebrates, those of Invertebrates have received much less attention. It seems that *Entamœba blattæ* Bütschli stands by itself: *Malpighiella* from the flea and the leech is a well-defined genus of which the division and encystment are known. Of the others, *Amœba chironomi*, with its *limax*-like nucleus and contractile vacuole, is not like any true parasitic amœba yet described, while Alexeieff regards *Entamœba aulastomi* from the horse-leech as identical with *E. ranarum* from the frog.

A description is given of *Löschia hartmanni* sp. n., a small amœba from the intestine of crane-fly larvæ. Encystment follows on copulation between gamete amœbulæ. The average diameter of the cyst is only 8 μ: the cyst wall is remarkably thick: within the cyst the zygote nucleus divides to form at least ten nuclei. This amœba is subject to the attacks of an organism that is probably allied to the *Micrococcus*, described by Nägler in his study of *Amœba horticola* and a small *limax*-amœba. Besides *Löschia hartmanni* there is a species of *Vahlkampfia* feeding well and dividing in the intestine of the larva of *Tipula*. Eleven different Protozoa are now known from this habitat.

Notes on Soil Protozoa.†—C. H. Martin and K. R. Lewin have established the occurrence of a trophic Protozoan fauna in certain field soils. In a cucumber bed they found *Vahlkampfia soli* sp. n., a very active form moving at times by means of a single large pseudopodium, and at other times by means of two anterior flagella. The significance of the flagellate stages is unknown: whether their appearance forms grounds for removing the *limax*-amœbæ from the group of true amœbæ and placing them amongst the Proteomyxa is a question that future work must decide. In the same bed they found *Amœba cucumis* sp. n., and in a seedling bed a species of *Euglypha*, *Chlamydophrys*, several

* Arch. Protistenk., xxxii. (1914) pp. 267–77 (2 pls.).
† Phil. Trans., Series B, ccv. (1914) pp. 77–94 (2 pls.).

species of amœbæ, a flagellate amœba, *Bodo caudatus* and *Amœba gobanniensis* sp. n., evidently closely allied to the *Amœba cucumis* found in the cucumber soil. It seems clear that the genus *Amœba* must be broken up, and a step in this reform has been taken by Chatton who founded the genus *Vahlkampfia* for the group of *limax*-amœbæ. It will probably be found necessary to form another genus for the *lamellipodia* group of amœbæ.

Rhizopods and Heliozoa from Fresh-water in Holland.*—H. R. Hoogenraad continues his study of the fresh-water Protozoa of Holland, and deals in his report with no fewer than 86 species of such genera as *Amœba*, *Difflugia*, *Arcella*, *Euglypha*, *Actinophrys*, *Clathrulina*, and *Clathrella*.

New Phytoflagellate and its Division.†—A. Pringle Jameson describes *Parapolytoma satura* g. et sp. n. obtained from a culture made by adding to garden soil some hay-infusion which had been boiled for several minutes. It has a superficial resemblance to the well known *Polytoma uvella*, but shows constant and well marked points of difference. At the obliquely truncated anterior end there is a quite unusual shallow depression; the whole body is surrounded by a substantial pellicle: there are two flagella arising from two small basal granules situated just under the membrane on the anterior end; there is no hint of any connexion between the nucleus and the basal granules. The nucleus is of the vesicular type with a central karyosome moored by delicate achromatin strands. Round the nucleus there is a small area of very granular cytoplasm, but elsewhere it is seen only as a fine meshwork surrounding great masses of reserve products. One contractile vacuole was seen at the base of the flagella. There is no chromatophore or eye-spot. The position of the organism is in the family Chlamydomonadidæ.

Within the pellicle there is division into four daughter-individuals. The division of the nucleus is described in detail. At no stage can any structure be found which could be interpreted as a centriole. The basal granules are of a very simple type, and are derived directly by budding from the karyosome of the nucleus.

Dermocystidium pusula Parasitic on Trout.‡—J. S. Dunkerly describes a stage of this parasite, which he found in a cyst on the gill of *Trutta fario*. The stage in question consisted of a plasmodium or a mass of ill-defined cells within a cyst wall. The next stage consists of a collection of distinct cells, each with a peculiar cell inclusion, and it is at this stage that the individual cells or spores (?) are set free by rupture of the cyst membrane. The fact that at one stage of its life-history the cells of *Dermocystidium* exhibit characteristic cell inclusion is another distinction, to be added to those enumerated by Pérez, between it and *Blastocystis* Alexeieff.

* Tijdschr. Nederland. Dierk. Ver., xiii. (1914) pp. 341–69.
† Arch. Protistenk., xxxiii. (1914) pp. 21–44 (1 pl. and 1 fig.).
‡ Zool. Anzeig., xliv. (1914) pp. 179–82.

Development of Trypanosoma noctuæ in the Gnat.* — H. M. Woodcock describes the developmental stages which are passed through in the female gnat (*Culex pipiens*) by *Trypanosoma noctuæ* of the Little Owl. Trypanomonad fusiform forms are the earliest developmental stages; these are transformed into an elongated trypaniform condition: there is a final much attenuated propagative form. Another line of development proceeds also from the original type of trypanomonad individual, by a modification in form and in mode of division. A club-shaped form with markedly unequal division results. In the mosquito there is the same club-shaped type, and this line of development leads ultimately to the production of small pear-shaped or oval parasites, with the nuclei close together and situated about the middle of the body, or nearer the posterior end, and with the flagellum drawn back but with practically no membrane. This is the haptomonad phase, which serves for attachment and coincident multiplication. The early development of *Trypanosoma noctuæ* in the mosquito culminates in the production of two distinct and extreme types — thread-like and haptomonad — the former being probably the propagative individual. After comparing *Trypanosoma noctuæ* with the two other parasites of the Little Owl, viz. *Halteridium noctuæ* and *Leucocytozoon ziemanni*, Woodcock comes to the conclusion that the three are entirely distinct.

New Hæmatozoon.† — Ed. Chatton and G. Blanc describe *Pirhemocyton tarentolæ* from the blood of the Gecko, *Tarentola mauritanica*, which also contains *Leishmania tropica*. The new parasite begins within the blood-corpuscle as a nucleated spherical body, about 1 μ in diameter, and grows into a pyriform body 3 to 4 μ in length by 1·5 to 2 μ in breadth. It is like a microsporidian spore, but has no envelope. It is situated in a vacuole in the cytoplasm. The parasitized blood-corpuscle shows in its cytoplasm a refractive inclusion, 7 to 8 μ in diameter, which seems to be due indirectly to the Hæmatozoon.

* Quart. Journ. Micr. Sci., lx. (1914) pp. 399–433 (3 pls. and 1 fig.).
† C.R. Soc. Biol. Paris, lxxvii. (1914) pp. 496–8.

BOTANY.

GENERAL,

Including the Anatomy and Physiology of Seed Plants.

Structure and Development.

Vegetative.

Leaf-anatomy of Andropogon.*—E. Breakwell has studied the leaf-anatomy of several species of *Andropogon* indigenous to New South Wales, with special reference to similarities or differences in the structure associated with the habit or habitat. From an anatomical standpoint the species fall into three groups: Group 1 including *A. intermedius*, *A. affinis*, and *A. sericeus*; group 2 including *A. Ischæmum*; and group 3 including *A. refractus* and *A. bombycinus*.

Group 1 is characterized as a whole by well-developed sclerenchyma, but *A. intermedius* shows well-defined structural differences from the other two species. The primary bundles of the midrib are more numerous, while there is also a larger number of secondary bundles accompanied by a corresponding increase in sclerenchyma. *A. sericeus* has the largest amount of sclerenchyma and serves as a connecting link with group 2, which has a much greater amount of this tissue, a thicker cuticle and more numerous and densely crowded vascular bundles. Group 3 shows extreme development of sclerenchyma and great thickening of the cuticle, while the stomata are in grooves on the lower surface, an arrangement not found in either of the other groups. Ecological characteristics are most marked in this group; in addition to other characters mentioned above, each of the species has water-storage tissue near the upper surface and the "girdle-canals" of *A. bombycinus* are probably useful in reducing transpiration. The habitat of these species corresponds with the sclerophytic characters. *A. Ischæmum* is intermediate between the species of group 1 and those of group 2, both as regards habitat and xerophytic characters. All the species of group 1 appear to be mesophytic both in structure and habitat.

Xerophilous Characters of Hakea.†—A. G. Hamilton has studied the morphological and anatomical characters of *Hakea dactyloides*, a shrub found in sandy regions and on the Hawkesbury Sandstone near Sydney. The stems are tough and woody and covered with hairs, while the vascular bundles contain numerous stout-walled fibres. The leaves are few, arranged spirally and vertically, and the size varies according to the season: there are three main veins and another of smaller size

* Proc. Linn. Soc. N.S.W., xxxix. (1914) pp. 385–94 (5 pls.).
† Proc. Linn. Soc. N.S.W., xxxix. (1914) pp. 152–6 (2 pls.).

round the margin. Numerous stomata are found on both sides of the leaves, and are overarched by small epidermal cells, among which are scattered capitate hairs; the cuticle is very thick. The mesophyll is composed of a double layer of palisade-cells separated by a layer of irregular rounded cells; there are no intercellular spaces except beneath the stomata. Embedded in the mesophyll are numerous scleroblasts, either simple and columnar or large branched structures, usually confined to the outer palisade-layer, through which the branches extend until they reach the inner wall of the epidermis, beneath which they expand. The leaves of plants grown in the shade differ greatly from those grown in the open. The leaf itself is thinner, the cuticle is thin and transparent, while both epidermal and palisade-cells are considerably shorter. There are fewer hairs and stomata, and the structure of the latter is less complex. Scleroblasts are rare, while the mesophyll is irregular and has intercellular spaces. The difference in structure is apparently an adaptation to xerophytic conditions. The thick dark-coloured cuticle, the regular and closely-packed mesophyll-cells with the accompanying scleroblasts, appear to have the same function, viz. to diminish transpiration. The sclerenchymatous fibres of the vascular bundles give rigidity to the leaf and also assist in the reduction of transpiration.

Reproductive.

Mechanism of Anther-dehiscence.*—M. Schips has studied the causes of the opening of anthers, and shows that the results of his experiments are in opposition to the theory supported by Hannig and other writers, according to which the opening is caused by contraction resulting from cohesion. In the first part of the work the author discusses the theory in relation to his own experiments dealing with (1) the air-contents of the anthers at the time of opening and the opening in moist air; (2) the formation of folds in thin membrane; and (3) the method of bringing about the opening by liquids capable of removing water; in each case it is maintained that the majority of the results are in conflict with the "cohesion theory." In the second part the author deals with the hygroscopic mechanism, and expresses the opinion that the shrinking of the thickened fibres is insufficient to cause opening. The present review by E. Hannig criticizes the unsatisfactory methods of experiments described and their untrustworthy results.

Delayed Germination of Alisma.†—W. Crocker and W. E. Davis have studied the germination of *Alisma Plantago*, with the following results: Dormancy of the seed is due to the mechanical restraint of the seed-coat, which enables the seed to remain in water for years without germination. Neither the wall of the carpel nor the outer seed-coat has any influence on dormancy, which is apparently due to the two inner seed-coats. The slightly swollen embryo lies for years within the saturated seed coat, against which it exerts a pressure of about 100

* Beih. Bot. Centralbl., 1te Abt., xxxi. (1913) pp. 1-92. See also Zeitschr. Bot., vi. (1914) pp. 564-7.

† Bot. Gaz., lviii. (1914) pp. 285-321 (8 figs.).

atmospheres. When the seed-coat is removed from the large end of the embryo, the latter is free to swell, and the seed gains 100 p.c. in weight in 20 hours. If the coat is removed from both ends, the embryo elongates 19 p.c. in $2\frac{1}{2}$ hours and 30 p.c. in 5 hours. This elongation is only due to growth in a very small degree, but an increase of 36 p.c. in length after 16 hours soaking involves considerable growth. The seed-coat is composed almost entirely of pectic compounds, easily transformed by weak acids and bases. Acids appear to increase the absorptive powers of the embryo and bases increase the rate of elongation, so that both bring about a weakening of the seed-coat. In common with the seeds of many other aquatic plants, the seeds of *Alisma* are capable of retaining their vitality for many years, when saturated with water. The embryo can elongate 120 p.c. at the expense of its stored foods, in the absence of free oxygen, but the latter is necessary for the development of the radicle and plumule and for the formation of chlorophyll.

CRYPTOGAMS.

Pteridophyta.

(By A. Gepp, M.A., F.L.S.)

Spermatogenesis in Marsilia.*—L. W. Sharp gives an account of spermatogenesis in *Marsilia*. In 1912 † he showed that the blepharoplasts of Bryophytes, Pteridophytes, and Gymnosperms are derived ontogenetically or phylogenetically from centrosomes. He summarizes his present paper as follows :—1. In the first spermatogenous mitosis there is present at each spindle pole a dense region with radiations, but no centrosome. 2. During anaphase of the second mitosis a centrosome develops at each spindle pole, and at telophase divides to two daughter-centrosomes. These only rarely develop farther; they usually degenerate at once in the cytoplasm. 3. In the third mitosis a centrosome develops at each spindle pole at anaphase exactly as in the second mitosis, and during telophase or later divides to two daughter-centrosomes. 4. These daughter-centrosomes, which may now be called blepharoplasts, move apart and occupy the spindle poles through the fourth or final mitosis. 5. The centrosomes are at all times accompanied by extensive radiations, which in the fourth mitosis give rise to the achromatic figure. When the centrosome divides there is present a central spindle and amphiaster as in animal cells. 6. Before the fourth mitosis is completed the blepharoplast becomes vacuolate and breaks up into a number of fragments. In the spermatid these form a band which elongates spirally in close union with the nucleus and bears the cilia. 7. The evidence afforded by *Marsilia*, together with that gained from other plants and certain animals, is believed to show conclusively that the blepharoplasts of Bryophytes, Pteridophytes, and Gymnosperms are derived ontogenetically or phylogenetically from centrosomes.

* Bot. Gaz., lviii. (1914) pp. 419–31 (2 pls.).
† Bot. Gaz., liv. (1912) pp. 89–119.

Pinna-trace in Ferns.*—R. C. Davie publishes an account of the pinna-trace in the Ferns. He briefly notices previous papers on the subject. There are two types of pinna-trace departure—the marginal and the extramarginal. 1. In the marginal type the first indication of the preparation for the departure of the pinna-trace, as the leaf-trace is followed up the petiole, is an extension of the mass of tracheides on the adaxial side of the petiole. In *Asplenium obtusatum*, a typical example, the two masses of xylem are curved in outline, the convex sides of the curves being directed towards each other. The adaxial extremities of these xylem masses become extended towards the adaxial corners of the petiole. As the pinnæ are not inserted exactly opposite to each other first the extremity of one and then that of the other xylem-mass is separated off from the parent trace. Phloem completely surrounds the xylem in both portions of the leaf-trace, and the marginal tracheides when nipped off are surrounded by a narrow ring of phloem. There are protoxylem elements at the abaxial tips of the leaf-trace and on the adaxial sides, not far from the ends. The pinna-trace has one small protoxylem group on one side at the time of separation. As the tracheides at the margin of the leaf-trace strand are separated from the parent strand to supply the pinna-trace, this type of pinna supply is termed marginal. 2. The extramarginal type differs in leaving the leaf-trace margins intact throughout the petiole. In *Didymochlæna truncatula* the leaf-trace is composed of several strands. The two adaxial strands have their margins sharply recurved, so that they are almost parallel to the adaxial surface of the petiole. To supply the basal pinna, the back of the hook is lengthened towards the adaxial corner of the petiole. Across the narrow space between the two strips of tracheidal tissue thus formed new tracheides spread. The original outline of the leaf-trace strand is thus re-formed, while a ring of tracheides is attached to the back of its hooked portion. This ring soon separates, to pass into the base of the pinna and then divide up into a pinna-trace resembling the leaf-trace. The margin of the parent trace remains intact during the process. Since the pinna-trace goes off from the outside of the parent strand, the method of supply is termed extramarginal.

Various modifications of these two types are described by the author; and he also gives a classified table of the results of his investigation. This table is the subject of a detailed discussion in which a comparison is made with the structure of the leaf-trace in fossil ferns. Further, the relationship of the tracheidal tissue to the water-supply of the upper part of the frond is discussed, together with the question why the marginal type of pinna-trace is more prevalent than the other.

Azolla filiculoides.†—W. H. Burrell gives an account of the morphology and development of *Azolla filiculoides*, and of its life-history as studied in Norfolk. He has specially examined the conditions of spore-germination—the requirements of moderate temperature, illumination, and aeration. He is strongly of opinion that the only species of

* Trans. Roy. Soc. Edinburgh, l. (1914) pp. 349–78 (3 pls. and figs.).
† Trans. Norfolk and Norwich Nat. Soc., ix. (1914) pp. 731–42 (1 pl.).

Azolla growing in the British Isles is *A. filiculoides*, and that the records of *A. caroliniana* are based upon error. He adds some notes on the recent spread of the plant over the Norfolk Broads.

Dryopteris.* C. Christensen publishes notes on some species of *Dryopteris* recently collected in tropical America, two of which—*D.* (*Lastrea*) *Shaferi* and *D.* (*Lastrea*) *Jimenezii*—are new to science; and their characteristic structure is described. In discussing the peculiarities of *D.* (*Stigmatopteris*) *cyclocolpa* the author claims that *Stigmatopteris* is worthy of generic rank.

Ferns of Lord Howe Island.†—W. W. Watts publishes some additional notes on the ferns of Lord Howe Island—the result partly of a recent visit to the island by R. B. Oliver. He founds a new species, *P. Whiteleggei* upon the plant locally known as "heavy fern," and states that his previous species *P. Kingii* is to be referred to *P. Moorei* Christ. Three species of *Dryopteris* grow in the island, and have been the subject of some confusion. *Marattia fraxinea* var. *salicina* appears to be a valid variety. *Ophioglossum vulgatum* var. *lanceolatum* is a variable plant and has been split into various species by previous writers. Four tree-ferns occur in the island; and Oliver's careful field-notes concerning their trunks, stipites, rhachises, costæ, etc. are incorporated: and a new description of *Alsophila robusta* C. Moore is added.

Bryophyta.

(By A. Gepp.)

Morphology and Development of Symphyogyna.‡—Florence A. McCormick publishes a study of *Symphyogyna aspera*, a Mexican hepatic, and gives the following summary: 1. The thallus has a central strand of greatly elongated cells which taper at both ends. The walls of these cells have narrow pores, spirally arranged. 2. The species is dioicous; and the male plants are more slender than the female. 3. The antheridia are dorsally scattered over the thickened part of the thallus, each antheridium being surrounded by a scale. 4. The archegonia occur in groups on the dorsal side of the thallus, each group being on a pad-like extension of the thallus and surrounded by an involucre. 5. More than one embryo may be formed in a group, but so far only one has been found to reach maturity. 6. As the embryo elongates, the calyptra and pad also elongate; and the old archegonia are left on the tip of the calyptra. 7. The young embryo develops by segmentation similar to that formed by a dolabrate apical cell. 8. The sporogenous tissue is differentiated relatively late in the history of the sporophyte. 9. The cells which are to form elaters may early be distinguished from the cells which are ultimately to give rise to the spore-mother-cells. The former cells

* American Fern Journ., iv. (1914) pp. 77–83.
† Proc. Linn. Soc. N.S.W., xxxix. (1914) pp. 257–62.
‡ Bot. Gaz., lviii. (1914) pp. 401–18 (3 pls.).

elongate without further division while the latter cells undergo several divisions. 10. The walls of the sporogenous mass of cells become gelatinized, and the protoplasts are potentially free in the gelatinous substance. 11. The spore-mother-cells attain their lobing by a slow amœboid change of the protoplast, and in this movement vacuoles seem to play an important part. The examination of the living sporogenous tissue of other Jungermanniales verifies the occurrence of this phase in them also. 12. Spores with two nuclei have been found, though this is not a usual condition.

Oxymitra in North America.*—M. A. Howe gives an account of *Oxymitra paleacea* Bisch. (*Tesselina pyramidata* Dumort.), an hepatic known only from the Mediterranean region until it was found in Balansa's Paraguay collection. Recently it has been gathered in Texas; and some of this sample is under cultivation in the New York Botanic Garden. The Texas plant may, however, prove to be a new species, distinct from the Mediterranean plant in the larger spores, the position of the antheridial inflorescence, and the structure of the stomata. The author discusses the tangled nomenclature of the generic and specific names.

The same author † publishes further notes on the Texan *Oxymitra* (*Tessellina*), a supplement to his paper on *Oxymitra paleacea* or *Tessellina pyramidata*.‡ The latter is a Mediterranean species, and is dioicous, but the Texan plant on being cultivated is found to be synoicous. The author therefore gives it the name *Oxymitra androgyna* sp. n., and describes its structure.

Marsupella.§—T. Husnot publishes notes on some species of *Marsupella*. 1. The cell-structure of *M. commutata* has been figured by the two experts Massalongo and K. Müller with very discordant results: the one showing ovoid, and the other quadrate cells. The cells are in reality hexagonal, as figured by Husnot, and when otherwise figured by other authors it is because the outline is taken not from the wall, but from the cytoplasm which lines it. The cells do not differ from those of *M. Funckii*, nor do the outline of the leaves, nor the shape of the lobes afford any trustworthy ground for distinguishing these two species. Husnot regards *M. commutata* and *M. badensis* as no more than forms of *M. Funckii*. 2. *M. ustulata* and *M. Sprucei* are distinguished by the larger size of the cells in the latter species—a character very variable on the same plant. Also the acute or obtuse lobes of the involucral leaves is no constant character. These two species are not distinct.

Bryum tophaceum.‖—L. Trabut discusses the identity of *Bryum tophaceum* D. R. & Mont., a moss gathered at Tiaret in Algiers more than sixty years ago, but sterile and almost unknown to bryologists.

* Bryologist, xvii. (1914) pp. 72–5 (1 fig.).
† Bryologist, xvii. (1914) pp. 92–4.
‡ Bryologist, xvii. (1914) pp. 72–5.
§ Rev. Bryolog., xl. (1913) pp. 76–7.
‖ Rev. Bryolog., xl. (1913) pp. 45–6.

Recently material obtained from the *locus classicus*, where it is abundant at the margin of streams, enabled V. F. Brotherus to demonstrate that it is a good species, and is not to be referred to *B. gemmiparum*, its nearest ally. From the latter it differs in its more distant leaves, its laxer reticulation, and by the vanishing of the nerve below the apex of the leaf.

Hylocomiopsis.* J. Cardot describes the characteristic structure of *Hylocomiopsis ovicarpa*, a Japanese species founded by Bescherelle in 1893, and placed in *Anomodon*. Cardot placed it in *Lescuræa*; and Brotherus gave it a special subgenus, *Trichocaulon*. But, inasmuch as it differs from *Lescuræa* in the marked dimorphism of its leaves, its branched paraphyllia, and its endostome with narrow, but not filiform cilia, and also the previous employment of *Trichocaulon* as a genus of Asclepiadeæ, Cardot proposes for the moss the name of *Hylocomiopsis*.

Hypnum lusitanicum in Finistère.†—L. Corbière gives a description of a puzzling moss which he gathered in a remote spot on the coast of Finistere, and which with difficulty he ascertained to be *Hypnum lusitanicum* Schimp. It belongs to the subgenus *Limnobium*, and it forms an addition to the French flora.

Filicicolous Hypopterygium.‡—J. Amann discusses a sterile *Hypopterygium* found growing on the trunk of a tree-fern, *Dicksonia antarctica*, in the Jardin d'Acclimatation in Paris in April 1903, and also on *D. Sellowiana* in the Jardin des Plantes. Upon seeing a herbarium specimen of *Hypopterygium Balantii* C.M., he soon found it to be identical with the Paris plants. *H. Balantii* was found in the fruiting state by H. Graef on an old trunk of *Balantium antarcticum* in the botanic garden at Charlottenburg, near Berlin. It belongs to the subgenus *Tamariscina* Kindb.

Orthotrichum tomentosum.§—P. Culmann discusses an *Orthotrichum* collected on the Bundstock in the Bernese Oberland at an altitude of about 8000 ft., which he had referred to *O. sardagnanum* until he came upon Glowacki's description of *O. tomentosum*, which differs only in having longer peristome teeth. *O. tomentosum* is only an extreme or high mountain form of *O. juranum*, which possesses the same radical tomentum, the same velvety calyptra, the same capsular form (16 striæ), the same split or even completely divided peristome-teeth, etc. And *O. juranum* may be but a synonym of *O. abbreviatum*, any difference of length of operculum being relatively unimportant.

Bryophytes of Morocco.‖—L. Corbière publishes a second paper on the bryological collections made by Lieut. Mouret in Morocco at Fez

* Rev. Bryolog., xl. (1913) pp. 22–3.
† Rev. Bryolog., xl. (1913) pp. 58–9.
‡ Rev. Bryolog., xl. (1913) p. 24.
§ Rev. Bryolog., xl. (1913) pp. 49–51.
‖ Rev. Bryolog., xl. (1913) pp. 51–7.

and Aïn Cheggag, a calcareous district. The total of 110 species is composed of 87 mosses and 23 hepatics, of which 29 mosses and six hepatics are new for the district and one moss is new to science—*Pottia* (*Gomphoneuron*) *Moureti*. Important notes are appended to some of the species. The little known *Bryum tophaceum* is recorded from a new station; and in view of stunted specimens of *B. gemmiparum* gathered at the same place, Corbière questions whether these may not be biological forms of *B. tophaceum*. Under *Riella Reuteri* is a note on Trabut's claims that *R. gallica* and *R. Battandieri*, and perhaps also *R. Notarisii* are to be referred to *R. Reuteri*.

North American Hepaticæ.* — A. W. Evans publishes a fifth chapter of notes on North American Hepaticæ, including seven species new to the North American flora, namely, *Metzgeria uncigera* Evans, *Cephalozia affinis* Lindb., *Lejeunea spiniloba* Lind. & Gottsche, *Taxilejeunnea obtusangula* Evans, *Crossotolejeunnea bermudiana* Evans, *Leucolejeunea xanthocarpa* Evans, *Frullania cucullata* Lind. & Gottsche. Three other species are recorded as with increased range of distribution. Careful critical notes as to structure, nomenclature, history, etc., are appended.

Mexican Mosses.† — J. Cardot publishes a tenth article on preliminary diagnoses of Mexican mosses. Though the death of Pringle in 1911 checked one source of collections, yet other travellers in Mexico, namely Arsène and Nicolas, C. R. Orcutt, H. Schenk, have sent their collections for determination. Eleven new species and some varieties are described and discussed in the present paper.

Thallophyta.

Algæ.

(By Mrs. E. S. Gepp.)

North American Fresh-water Algæ.‡ — E. N. Transeau publishes descriptions of thirteen new species of fresh-water algæ collected in Illinois, namely *Zygnema* (1 species), *Spirogyra* (7 species and 5 varieties), *Mougeotia* (1 species), *Œdogonium* (4 species). He is engaged in studying the periodicity of occurrence and reproduction of the local algal flora.

Batrachospermum.§ — S. R. Price discusses the peculiarities of some forms of *Batrachospermum* collected near Cambridge. Some material

* Bryologist, xvii. (1914) pp. 87–92.
† Rev. Bryolog., xl. (1913) pp. 33–40.
‡ Amer. Journ. Bot., i. (1914) pp. 289–301 (5 pls.).
§ New Phytologist, xiii. (1914) pp. 276–9 (figs.).

gathered in October 1913 consisted of pale normal plants mixed with dark-coloured plants which were characterized by bearing large numbers of peculiarly contorted and considerably hypertrophied trichogynes. No trace of fungal or animal parasites could be found to account for this hypertrophy. But spermatia were often observed attached to them; and carpogonia were frequently developing. In the structure of the axis and form of the thallus considerable variation was noted. These details are discussed and dimensions are given. It is probable that a series of growth forms of *Batrachospermum moniliforme* composed the material examined; and that in certain condition, this species is an extremely variable one, producing forms which are probably not definite enough to merit the name of species or even of true varieties. No explanation of the hypertrophied trichogynes is at present forthcoming.

Scinaia.* — W. A. Setchell publishes the results of his studies on the *Scinaia* assemblage. After an account of the history of the genus, he describes the materials, the technique, and the morphology. The author recognizes three genera in the assemblage, *Scinaia*, *Gloiophlœa*, and a new genus *Pseudoscinaia*. Each genus and species is described fully, with the addition of valuable critical notes. A synopsis and a key to both genera and species is given. A chapter on geographical distribution concludes the paper. *Scinaia* seems to be essentially a northern hemisphere type, since nine of its eleven species are confined to a position north of the equator, and these represent all the various types of structure within the genus. Both *Gloiophlœa* and *Pseudoscinaia* have an equal number of species in each hemisphere. Valuable structural drawings illustrate the work.

Marine Flora of Tatihou and of St. Vaast-la-Hougue.† — P. Hariot publishes an interesting note on some of the marine algæ of the island of Tatihou and of St. Vaast-la-Hougue. The flora has been well worked by Thuret, Bornet, and others. In the present note the author records several novelties in the district, *Cordylecladia erecta*, *Phyllophora Traillii*, *Erythrotrichia Welwitschii*, *Ralfsia deusta*. On the other hand, several other species, previously recorded, have disappeared — *Codium Bursa*, *Enteromorpha aureola*, *Striaria attenuata*. Other species, again, have disappeared from their previous habitats, to reappear at others. Two species are endemic, *Stereococcus Malardi* Wille, and *Polysiphonia rhunensis* Thuret. The author notes the fact that *Fucus ceranoides* grows at the mouth of the Saire, and is always hermaphrodite. He suggests that an observer might do well to study the development of certain species, with their appearance and disappearance. *Padina Pavonia* and *Chorda Filum*, growing in well-marked spots, would lend themselves well to such study; and the building up of the simple or branched filaments of diatoms in brackish water, classified by the older diatomists as *Schizonema*, deserves attention.

* Univ. California Publications (Bot.) vi. (1914) pp. 79–152 (7 pls.).
† Comptes Rendus, clix. (1914) pp. 689–92.

Fungi.

(By A. Lorrain Smith, F.L.S.)

New or Peculiar Zygomycetes.*—R. Thaxter has added three new genera of moulds to the fungus flora, all of them well-marked and well-tested. The first, named *Blakeslea* in honour of Professor Blakeslee, appeared in a culture of *Botrytis Rileyi*. The larvæ attacked by the *Botrytis* were found on cow-peas at Gainesville, Florida, and the spores of the mould may have been lodged on the flowers of the plants and have become transferred to the body of the insect. The mycelium is colourless to bright orange; the sporangia are variable in size, they are spherical, nodding, or circinate, and solitary at the tips of the sporangiferous hyphæ. There are, in addition, fertile hyphæ that bear twelve or more sporangiola, or each hypha branches at the tip and forms swollen heads, which become studded with sporangiola, all typically three-spored, rarely more. Chlamydospores are also produced.

Thaxter considers that *Blakeslea* is closely allied to *Choanephora*, and he compares several species of that genus with the new fungus.

The second new mould, *Dissophora decumbens*, was found on dung of the wood-mouse, in the vicinity of Cambridge, Mass. It is closely allied to *Mortierella*, but is distinguished by the peculiarities of the fertile hyphæ. These arise as branches continually given off from a constantly advancing main filament. It is at first erect, but soon becomes decumbent. The sporangia are similar to those of *Mortierella*.

Haplosporangium bisporale, the third new genus and species, is also allied to *Mortierella* in the character of the sporangia. There is a felted layer of mycelium, on segmented portions of which sporangiophores are radially produced. They are short branchlets, and taper to a point before bearing the sporangia. The latter are monosporous or bisporous. In habit the fungus resembles a *Cephalosporium*, and does not appear to be rare. A second species of the genus, *Haplosporangium decipiens*, was distinguished by the sporangia being nodding and having the walls roughened by minute folds. There is no record of zygospores having been formed in the cultures.

Studies of Laboulbeniaceæ.†—Clodomiro C. Tonghini finishes his account of this group of Fungi. He describes the various attempts to make satisfactory microscopic preparations, the best results being attained by embedding in hard paraffin and by paying particular attention to the plane at which the sections were cut. He was thus able to study minutely the different organs—the foot and rhizoidal structures, the perithecium and the appendices, all of which he describes generally, more particular descriptions being reserved for the different diagnoses of genera and species.

* Bot. Gaz., lviii. (1914) pp. 353-66 (4 pls.).
† Malpighia, xxvi. (1913) pp. 477-518 (1 pl.).

In discussing reproduction, he gives an account of the male organs or appendices, and gives the views of himself and others as to the significance of those structures, some of them being fertile and others sterile. The latter which surround the spermatic threads may be considered as merely protective, or they may have some nutritive function.

The perithecium, or female organ, was also examined, and the author lays stress on the perfection of its development, that being a strong argument, he concludes, for the sexuality in these Fungi, though the cytology is not yet perfectly understood. The spores which are produced within the perithecium are expelled in a gelatinous mass: they consist of two unequal cells, and the larger is always the foremost.

Then follows a long discussion on the nutrition of the Laboulbeniaceæ: the author concludes that they are all parasites and draw their nourishment from the host by means of rhizoids, more or less developed. If sufficient nutriment is not obtained in the epidermis, the rhizoids penetrate the lower strata.

A synoptic key to the genera is given in the systematic part of the paper with descriptions of European genera. A list is also drawn up of the insect hosts of the Laboulbeniæ with the parasite peculiar to each, and a full bibliography of the subject is appended.

Roland Thaxter * has published an account of Laboulbeniæ parasitic on beetles belonging to the Chrysomelidæ, the result of prolonged observation of this particular section of the family. He criticizes genera and species determined by Spegazzini on Argentine beetles. The larger number of species belong to the genus *Laboulbenia*, but two other genera are also represented by well-marked forms: *Dimeromyces* contributing four species from Mexico, the West Indies and the Straits Settlements; while seven species of *Coriomyces* are included, six of them parasitic on "flea beetles" from the West Indies and Brazil, the seventh a very peculiar form from the Cameroons and Madagascar. The species described were all obtained from tropical regions.

Outbreak of Rust on Winter Grain in Bavaria.†—L. Hiltner has studied the conditions attending attacks of rust disease on wheat and rye due to *Puccinia glumarum* and *P. triticina*. The ears were badly attacked, though even in that case the loss to the wheat crop may not be very great.

There is a general consensus of opinion that rust is favoured by one-sided nitrogenous manuring, especially with nitrate of soda. It has been also found that yellow rust was less severe on fields properly manured, and that thin crops were far more severely attacked than an even crop covering the ground properly. While unbalanced nitrogenous manuring favours rusts, dressings of phosphate prevent the attack, and cereals that follow a green manure crop are also little subject to the fungus.

The main cause of rust epidemic is the state of the weather: hot

* Proc. Amer. Acad. Arts and Sci., l. No. 2 (1914) pp. 17–50.

† Wochenschr. Landw. Ver. Bayern, 1914, No. 25. See also Bull. Agric. Intell. Pl. Dis., v. (1914) p. 1091.

days followed by frosts or heavy dews, and then by cool weather, check the growth of the crops and make them susceptible to the attack of the fungus.

The writer suggests the advisability of a comparative enquiry throughout Europe as to the conditions leading to epidemics of rust disease.

Fungi of New South Wales.*—Edwin Cheel writes a short review, enumerating the more common fungi that occur in New South Wales. Many species have been discovered and recorded since 1892 when Cooke published the Handbook of Australian Fungi. Many of the forms common in Australia are equally familiar in our own country; they have become naturalized in the pasture lands throughout the State. Among these, *Coprinus comatus*, *Agaricus campestris*, *Lepiota procera*, *Stropharia semiglobata*, are well known to all mycologists.

Among Polyporaceæ, the common forms are more peculiarly Australian. *Polyporus eucalyptorum* is frequently found on a species of *Eucalyptus* known as Stringybark, the sporophore is whitish and soft, the mycelium occurs in thin whitish sheets wrapped round the heart-wood of the tree.

Polystictus cinnabarina is very common on fence-rails and fallen branches; *Polyporus Mylittæ* is occasionally found. Several *Boleti* are mentioned, and *Stereum lobatum*, a common species in warm countries.

During the rainy weather of January and February a number of peculiar Gasteromycetes are met with: *Aseroe rubra*, which resembles a sea-anemone. *Clathrus cibarius*, called the "Lace-ball Fungus," and *Lysurus australiensis*, or "Deadman's Finger."

Microfungi are also very abundant, either native or introduced. Uredineæ, Ustilagineæ, and Ascomycetes are all well represented. Entomogenous fungi are not uncommon; species of *Cordyceps* found on caterpillars and minute forms belonging to the genera *Myriangium* and *Microcera* which attack scale-insects, and may have considerable economic importance.

Cheel also adds a note on Mycetozoa, which are abundant.

Fungi in South Australia.†—T. G. B. Osborne has given a summary of the fungoid products of South Australia. They have been much less worked than those of some of the other States; there are only about 12 p.c. known of the total number of species recorded for the Commonwealth. Among the more remarkable fungi occurring in the State are the luminous *Pleurotus candescens*, which grows on dead Eucalyptus stumps, and *Polyporus Mylittæ*, which forms bulky sclerotia.

Another curious fungus belonging to the Polyporeæ has been described under the name of *Laccocephalum basilapiloides*. It is found in mallee country, and the mycelium forms dense accretions of the sandy soil at the base of the fungus stipe. The stony masses are roughly egg-shaped, and measure as much as 12 cm. long and 8·5 cm. thick.

* Brit. Assoc. Handbk. New South Wales, 1914, pp. 453–7.
† Brit. Assoc. Handbk. South Australia, 1914, pp. 22–3.

Suspended Vitality in Fungi.*—Buller and Cameron have experimented with the fruiting bodies of some of the larger fungi, to test the length of time they can retain their power of growth after being dried up. *Dædalea bicolor* was kept in the dark, exposed to ordinary room temperatures for at least seven years and a half, and retained vitality. *Schizophyllum commune* revived after a period of five years and seven months. Further experiments were made by exposing the fungi to phosphorus pentoxide and to the temperature of liquid air. In the latter case they were kept at the low temperature for three weeks, and still retained their vitality.

Fungus Disease of Plants.†—A disease on Pepper due to *Colletotrichum nigrum* is described by C. K. Bancroft. It appeared first in the form of spots at the apex or on the sides of the fruit. Concentric circles then form round the point of infection, and the whole fruit may become diseased and fall off. The fungus may also spread down the stem. The disease spread so fast that some plants lost all their yield. The treatment adopted was to cut back the infected plants and spray repeatedly with Bordeaux mixture.

C. K. Bancroft‡ also writes about a disease affecting Sisal Hemp caused by *Colletotrichum Agaves* in British Guiana. The parasite so far as is known has only attacked plants at some distance from the coast. The fungus has been cultured and again reproduced on the host, but only when the latter was injured, thus confirming the conclusion that it was a wound parasite.

The same writer§ describes the action of *Marasmius Sacchari*, the "new disease" or "dry disease" on Sugar-cane, first observed in the colony in 1907. The report is mainly concerned with the means employed to get rid of the parasite. More resistant varieties of the sugar-cane have been generally planted with good effect.

P. A. Saccardo and B. Peyronel‖ describe two new species of fungi found on Tobacco Seed Beds. They are *Glœopeziza turricola*, a Discomycete which looks like brick-red dots on the soil and appears early in the pan on the warm protected beds. It develops in patches and forms a crust that hinders the development of the germinating tobacco seeds. The second species *Hyalopus geophilus* is a white mould (Mucedinaceæ), and develops on the same places as the *Glœopeziza*. Sterilization of the soil killed off both fungi.

Fungus Diseases in South Australia.¶—T. G. B. Osborn has prepared a short general account of fungus diseases in the southern

* Trans. Roy. Soc. Canada, vi. (1912) pp. 73–8. See also Bot. Gaz., lviii. (1914) pp. 375–6.

† Journ. Board Agric. Brit. Guiana, vii. No. 3 (1914) pp. 139–40. See also Bull. Agric. Intell. Pl. Dis., v. (1914) p. 1092.

‡ Journ. Board Agric. Brit. Guiana, vii. No. 4 (1914) pp. 181–2. See also Bull. Agric. Intell. Pl. Dis., v. (1914) pp. 1246–7.

§ Journ. Board Agric. Brit. Guiana, vii. No. 4 (1914) pp. 183–7.

‖ Boll. tec. coll. tabacchi, Salerno, xiii. No. 1 (1911) pp. 3–6 (1 pl.). See also Bull. Agric. Intell. Pl. Dis., v. No. 9 (1914) pp. 1247–8.

¶ Brit. Assoc. Handbk. South Australia, 1914, pp. 24–7.

state of Australia. He notes two prevalent wheat-infecting rusts — *Puccinia graminis*, or black rust which occasionally does very serious damage, though the general dry weather which precedes harvest lessens the danger of serious mischief; and another common rust, *P. triticina*, which only attacks the leaves of the wheat and is not of much economic importance.

Among smuts *Urocystis Tritici* is one of the most important. Infection of the host-plant occurs at the seedling stage before the wheat appears above ground; infected plants rarely produce grain.

Ophiobolus graminis or "take-all," a pyrenomycetous fungus, also gives serious trouble in wheat-fields. The seedling roots are attacked and the fungus spreads upwards through the plant tissues. Barley is also severely attacked; oats less frequently.

Fruit-trees suffer from *Exoascus deformans*, and from various shot-hole fungi. These may spread from the leaves to the fruit and cause a disfigured stunted appearance from the scabbed areas of the fungus growth.

Potatoes are the only root-crop of importance, and since 1909 *Phytophthora infestans* has been recorded. Owing, however, to the dry condition, it rarely causes the rot of haulms and leaves so common in Britain. Sclerotia of *Rhizoctonia* are common, but though tubers are frequently injured, the cause of injury is more probably *Oospora scabies*, which does so much harm in the United States. Growers are hampered by the small area of ground suitable for potato cultivation, so that it is difficult to change the crop.

Lichens.

(By A. Lorrain Smith, F.L.S.)

British Wandering Lichen.* — Robert Paulson and Somerville Hastings describe the origin and development of an unattached lichen from the Downs near Seaford, but confined to a small area of about eight acres. The specimens correspond to *Parmelia revoluta* var. *concentrica* Cromb. At first it was suggested that the lichen may have commenced life on some tree and been blown on to the downs. There were no tree-bearing lichens anywhere near, and the problem was at last solved by the discovery of some flints with *Parmelia revoluta* growing on them and gradually becoming panniform. The lichens in time become dislodged from the flints. They are very dry and are probably occasionally rolled over by a strong wind. Some of them attain an almost spherical contour, being made up of concentric layers of laciniæ. They are easily broken, by the trampling of sheep, etc., and each broken portion may develop anew. Erratic lichens occur elsewhere, but this is the only British lichen with this peculiar habit of growth.

* Knowledge, xxxvii. (1914) pp. 319–23 (9 figs.).

Lichens of New South Wales.* —Edwin Cheel has given a short sketch of the lichen flora of the State, more particularly in the Sydney district. Owing to the crumbling nature of the sandstone rocks, the neighbourhood of Sydney is not rich in quantity, but a considerable number of species are represented. Many of them are cosmopolitan, others are peculiar to Australia. He enumerates the brilliantly coloured *Xanthoria parietina*, *Theloschistes chrysophthalmus*, and *Kunzea corifolia*, which grow on trees along the foreshores of the harbour. On the ground of the Wanamatta Shale series he records *Heterodea Muelleri*, *Clathrina aggregata*, and *Cladonia difissia*: and on logs, *Thysanothecium hyalinum*, which is peculiar to Australia. In the Blue Mountains he enumerates several familar species, such as *Rhizocarpon geographicum* and *Peltigera polydactyla*.

Lichen Flora of the Erzgebirge.†—E. Bachmann continues his field studies of Lichens. He gives a topographical and geological account of the district he worked through—the mining district of Saxony. The two principal types of rock are quartz-porphyry and basalt. There are occasional outcrops of lime, but these are grown over by shrubs and trees which give a dense shade so that almost the only rock lichen of that formation was *Lecanora erysibe*

The woods of the district are even more uniform than the geological formation, consisting near Altenburg of pine wood with very scanty lichen growth. In districts where mountain ash and hazel grew he found *Arthonia radiata* and *Arthopyrenia punctiformis*.

On the Kahleberg the yellow species of *Rhizocarpon* were abundant, and in addition *Lecidia pantherina*, *L. sudetica*, *L. lygæa*, and species of *Cladonia*. Lists are given of lichens common to the district but absent from the district of Rittersgrün previously worked through by the author.

A comparison is also made with the lichen flora of the island of Rügen. He notes that the lichens of the Erzgebirge are practically the same whether they grow on the tops or sides of the rocks, whilst on the island the upper surfaces are either barren or covered with *Lecanora saxicola*, *Xanthoria lychnea*, and *Candellaria vitellina*.

Bachmann was able to establish a difference between the lichens of acid and basic rocks; acid rocks containing 70 p.c. and more of oxide of silica such as quartz and granite-porphyry; and basic rocks, diabase and basalt, not reaching 50 p.c. He found that *Rhizocarpon geographicum* was the most frequent lichen of porphyry, while on basalt there were only small scattered patches. *Pertusaria corallina* was common on granite and on porphyry, but was not found on greenstone or basalt. *Pertusaria lactea* f. *cinerescens*, *Diploschistes scruposus* and *D. bryophilus* along with *Buellia leptocline* prefer the basic substratum. Porphyry and basalt are alike physically except for a difference in colour and therefore in power of radiation, but the chief difference lies in the chemical constitution. A list of 198 species is given with their habitats and localities.

* Brit. Assoc. New South Wales, 1914, pp. 457–8.
† Hedwigia, lv. (1914) pp. 157–82.

American Species of Ramalina.* —The two final parts (VII and VIII), on the genus *Ramalina*, have been recently published by Heber Howe. They comprise diagnoses of a number of species, with critical notes and an exhaustive review of the nomenclature. A number of changes have been made in the names, *R. usneoides* becoming *R. Usnea*, an older Linnean designation. In the latter number is printed a key to the genus. Howe has left *R. thrausta* in the genus *Alectoria*, where it was placed by Acharius; the filamentous cortex is *Alectorian* in character, and fruits are unknown.

Noteworthy Lichens from Maine.† —In this concluding paper, G. K. Merril records a number of species of the genus *Lecanora*, some of them new records for America. With reference to *L. subfusca* var. *campestris*, he gives the habitat not only on rocks near the sea, but also on the base of trunks of trees, and on decorticated wood at times inundated. *L. rugosa* he found exactly as described by Crombie, and considers it a good species, though it is frequently regarded as merely a variety of *L. subfusca*. *L. lævata* he found on rocks in the bed of a stream. Several *Pertusarias* are also included in the list, all new to America.

Nomenclature of the Genus Usnea.‡ —R. Heber Howe has worked out the recorded history of the genus and species, based on the Linnean types and descriptions. *Usnea florida* represents the plant long known as such. Two good specimens are mounted on one sheet and labelled in Linnaeus' handwriting. The form *hirta* is also preserved in the herbarium at Burlington House, but it is atypical. Regarding *Usnea plicata*, Howe says there is no true type-specimen, so he falls back on the description by Linnæus, which is based on a plate of Dillenius. It is a coarse pendulous species, determined later by Shaerer as *U. ceratina*, which name was adopted by Crombie. The true *U. ceratina* of Acharius is a prostrate and entirely asperate species. The species name *U. barbata* has also been revived, and is the true name for our *U. dasypoga*. The North American Linnean species therefore are: *U. florida* Web., *U. plicata* Web., *U. barbata* Web., and *U. articulata* Hoffm.

Schizophyta.

Schizomycetes.

Endemic Adenomycosis.§—E. Diaz describes a hitherto unrecognized disease which has been met with in the mining provinces of Brazil. The disease commences with the painless enlargement of a cervical lymphatic gland, the condition rapidly spreading to all the glands in the anterior triangle of the neck on both sides. Some months later fever

* Bryologist, xvii. (1914) pp. 65–8, 82–7 (2 pls.).
† Bryologist, xvii. (1914) pp. 76–9.
‡ Bull. Torrey Bot. Club, xil. (1914) pp. 373–9 (6 pls.).
§ Brazil Medico, xxviii. (1914) pp. 133, 134, 153.

and cachexia supervene, and the patient dies after a lapse of two or three years. From the expressed juice of the affected glands, a spore-bearing mould has been cultivated, which is pathogenic to laboratory animals. On Sabouraud's maltose medium a growth of small prominent yellow colonies becomes visible after some three days, and after 20 days a white filamentous mass of spore-bearing hyphæ develops. On maltose-agar, after two days, small points appear, pale brown in colour with a smooth surface and sharp edges. After 45 days aerial hyphæ become visible, at first white, but afterwards turning slightly yellow. The spores, from 2μ to 3μ in length, are arranged in clusters or chains. The hyphæ sometimes form bundles as much as 4 cm. in length by 1 mm. in diameter. The name of "*Adenomycosis cruzi*" is proposed for this new mould, as the discoverer cannot find any previous description of a similar organism in the literature.

Report on Gas Gangrene.*—Sir A. Bowlby and S. Rowland briefly record their observations on the spreading gangrene which has occurred among the wounded of all the armies now in France. Bacteriological examinations were carried out by Rowland at the Mobile Field Laboratory, and a bacillus was isolated from a typical case for examination. A culture inoculated into a guinea-pig killed the animal in eighteen hours. Post-mortem there was found a gangrenous cellulitis from which the infecting organism was recovered in pure culture. A second pig was inoculated and sent to the Lister Institute for further investigation. The animal arrived safely and died shortly afterwards.

The view is held that this organism is identical with one that was for some time confused with that of malignant œdema, known as the bacillus of Ghon and Sach. A sample of earth from a trench was also examined. The earth was shaken up with a little water and then inoculated into a guinea-pig. The animal, which died in eighteen hours, also presented the features of a gangrenous cellulitis, and was found to be infected throughout with a spore-bearing anaerobe belonging to the same group. It is concluded that the gangrene found among our wounded soldiers is directly due to infection introduced at the time of the wound, and this is especially likely to occur if muddy clothing has been carried in by the projectile, or if earth has been carried in by the explosion.

Thermoprecipitin Method in Diagnosis of Plague Cadavers.†—Charlotte E. Warner has applied the thermoprecipitin method of Ascoli to the diagnosis of plague in rat cadavers with considerable success. The technique follows the lines laid down by Ascoli in his investigations with regard to anthrax. The extract prepared from plague-infected material is placed in contact with a layer of immune plague serum, a positive reaction being indicated by the appearance of a whitish ring at the surface of contact. The reaction is specific, and if carried out with suitable controls, the occurrence of a marked positive reaction is absolute proof that the organ used for the preparation of the extract was infected

* Brit. Med. Journ., 1914, No. 2813, pp. 911-12.
† Journ. Hygiene, xiv. (1914) pp. 360-70.

with *Bacillus pestis*. A negative reaction is, however, of no value, as the organ used may have been pest-infected, but the number of bacilli present may not have been sufficient for the purposes of the test. While in no way replacing the recognized methods of plague diagnosis, the thermoprecipitin reaction "by reason of its speed, simplicity, independence of climatic conditions, or putrefaction in the cadaver, and availability in addition to the usual bacteriological methods, is a valuable supplement to them."

Human and Rat Leprosy.*—A. Philibert directs attention to the striking resemblance of human to rat leprosy with regard to geographical distribution, clinical features, pathology, and bacteriology, all of which point to the closest relationship or actual identity of the Hansen bacillus with the bacillus of Stefansky. Philibert believes that the rat strain has now lost its power of infecting human beings, and that consequently rats suffering from rat leprosy cannot be considered as dangerous to humans.

New Pathogenic Oospora (Oospora bronchialis).†—A. Sartory and Ph. Lasseur have isolated a new species of *Oospora* from the expectoration of a patient detained at the military hospital at Nancy about the time of the outbreak of the European War. He was suffering from cough and breathlessness accompanied by rapid emaciation. The fungus was isolated from small yellowish-white masses which were found suspended in the sputum. After two months' treatment with potassium iodide the patient was on the high road to recovery.

The parasite was isolated by plating out on maltose-gelatin-agar. An exact idea of the structure of the organism can be obtained by cultivating it in a hanging drop in maltose broth at 37° C. After 24 hours the mycelial filaments become elongated up to 2 mm. in length. These filaments, which are fixed and are entangled one with the other, possess regular lateral ramifications. These ramifications appear first on the sides of the principal filaments in the form of little nipples with rounded-off extremities. The conidia come into being at the free extremity of a filament, which becomes elongated and swells itself so as to constitute a little club separated from the parent filament by a partition. This phenomenon keeps on repeating itself, and results in a series of conidia being formed one behind the other, so as to form a little chain, the free conidia having the form of little barrels. These chains are very fragile, and are easily broken or detached. The number of the conidia varies from 15 to about 20, and the largest measure some $0 \cdot 6\,\mu$. These characters are those of a fungus of the genus *Oospora* Wallroth. The organism does not grow on broth, Raulin's medium, carrot, potato, banana, etc., but develops on the addition of maltose to the various media. The parasite is pathogenic for the guinea-pig and rabbit, which animals reveal, post mortem, a bilateral purulent pleurisy, the lungs being capped with a false membrane. The parasite resembles

* Progrès Médical, xlii. (1914) pp. 210-12.
† Comptes Rendus, clix. (1914) pp. 758-9.

the *Oospora pulmonalis* of Roger and Sartory, but the biological and morphological differences appear to be such as to warrant the creation of a new species, to which the name *Oospora bronchialis* has been given.

Bacterial Flora of Wounds.*—Doyen and Yamanouchi present a preliminary note on their observations with regard to bacterial infections on the field of battle. Their investigations have been made principally in relation to "gas gangrene," and they state that they have invariably found the *Bacillus perfringens* associated with this condition. With regard to treatment, their observations show that, provided the septic focus receives early attention, excellent results may be obtained by the application of compresses of "solution chlorurée de liqueur de Labarraque" diluted to 10 or 20 parts per 1000.

Bacterial Researches on Gas Gangrene.†—M. Weinberg states that in all the cases of gas gangrene that he has examined among the British troops at the front, he has found a large Gram-staining bacillus, which answers in all its morphological and biological characters to *Bacillus Welchii* (*B. perfringens*). This anaerobic organism was always found to be associated with aerobes (or facultative anaerobes), such as *B. proteus*, staphylococci, and streptococci. A common combination was found to be *B. perfringens*, diplococci, and *B. proteus*. Although the author admits that one is not able to state that all cases of gas gangrene are due to the same organisms, yet he is of opinion that *B. perfringens* plays a very important part in the etiology of this condition.

Ferment contained in Water.‡—E. Voisenet has previously described an organism (*Bacillus amaracrylus*) present in bitter wines, which, by the action of an enzyme contained in its substance, is able to transform glycerin into acrolein. Working with "Dijon water" inoculated into a glycerinated mineral medium, he has produced abundant cultures of a bacillus which presents the morphological characters of *B. amaracrylis*, and, like it, is capable of dehydrating glycerin. The biochemical properties of the two organisms are, moreover, identical, and it is more than probable that we are here dealing with one and the same bacillus. Further researches with regard to the pathogenicity of the new strain are being proceeded with.

Bacillus bifidus in the Intestinal Canal.§—C. A. Kling endorses the conclusions of Tissier with regard to the bactericidal action of *Bacillus bifidus*. The experiments were conducted with emulsions of *B. coli*, *B. lactis aerogenes*, *Proteus vulgaris*, and *Staphylococcus aureus*, and in every case the markedly inhibitory action of *B. bifidis* was manifested. The inhibitory substance was found to be present in the culture fluid, and was recoverable after filtration through a Chamberland filter; and also after dialysis. It was ascertained to be thermostable, and to be

* C.R. Soc. Biol. Paris, lxxvii. (1914) pp. 503–4.
† C.R. Soc. Biol. Paris, lxxvii. (1914) pp. 506–8.
‡ Ann. Inst. Pasteur, xxviii. (1914) pp. 807–18.
§ Ann. Inst. Pasteur, xxviii. (1914) pp. 797–806.

readily neutralized by the addition of alkalines. The inhibitory effect is doubtless produced by the formation of acids (lactic and acetic) by the bacillus from the sugar in the medium in which it is grown. *B. bifidus* is generally found in the intestinal tract of breast-fed infants, and it is not unreasonable to suppose that the acid reaction of the fæces of such infants is due to the activities of this organism, which, therefore, plays an important part in the protection of the intestine against the harmful influence of pathogenic micro-organisms.

Sulphur Bacteria.*—G. A. Nadson describes a number of interesting sulphur bacteria from brackish water in the Gulf of Finland. Two of the forms described are peculiar, from the fact that the cells contain in addition to stored sulphur a substance which readily decomposes into oxalic acid. These bacteria live in badly aerated mud, and by increasing the oxygen supply the oxalite-like substance was found to increase and the accumulation of sulphur to diminish, and vice-versa. A remarkable new genus of sulphur bacteria called Thiosphærella was discovered which contained in its cells large quantities of a starch-like substance. The other forms described are new species of the genera Achromatium and Thiophysa.

Spirochætosis of the Bovine Hæmoglobinuria of Chile.†—J. Blier, after describing the chief symptoms, states that at the outset of the disease an organism can be found. It is longer than most known spirochætes, sometimes exceeding 60 μ and then being 1 μ thick. When shorter it is swollen in the middle. Sometimes the undulations are of regular amplitude, but this is not invariable. One extremity of the body is thinner than the other, and the organism takes a uniform Giemsa staining. Stained with Borrel's eosin-blue, bright red granules become apparent. An excellent photograph revealed a flagellum at each end.

* Bull. Imperial Bot. Gard. Petrograd, xiii. No. 4. See also Nature, xciv. (1914) p. 458.

† Comptes Rendus, clix. (1914) pp. 815–17.

Feb. 17th, 1915

MICROSCOPY.

A. Instruments, Accessories, etc.*

(1) Stands.

Small Comparator.†—This instrument (fig. 2), made by the Cambridge Scientific Instrument Co., consists of a cylindrical steel tube about 500 mm. long which is supported in geometric bearings on a rigid frame, and can be fed backwards and forwards by means of a micrometer screw of 1 mm. pitch. The micrometer head is divided in 100 parts and readings can be estimated to 0·001 mm. The screw has a pitch of

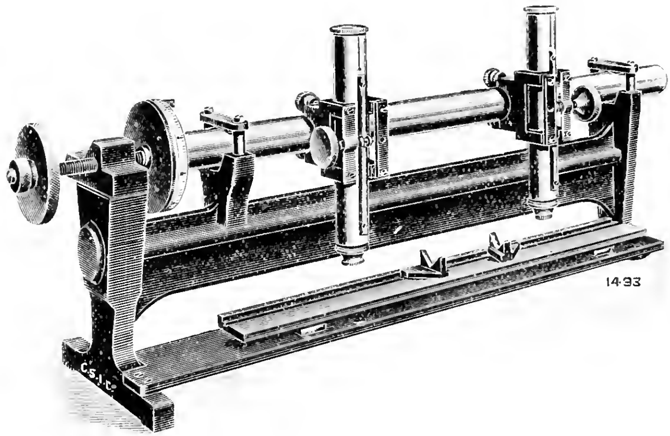


Fig. 2.

1 mm. and is free from backlash. Two Microscopes with achromatic objectives are clamped to the steel tube. They are fitted with the Lucas slow motion focusing mechanism which gives a very smooth movement and is also free from backlash. The scale under observation is supported on the base of the instruments and scales of any length may be checked.

* This subdivision contains (1) Stands: (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Cambridge Scientific Instrument Co., Ltd.

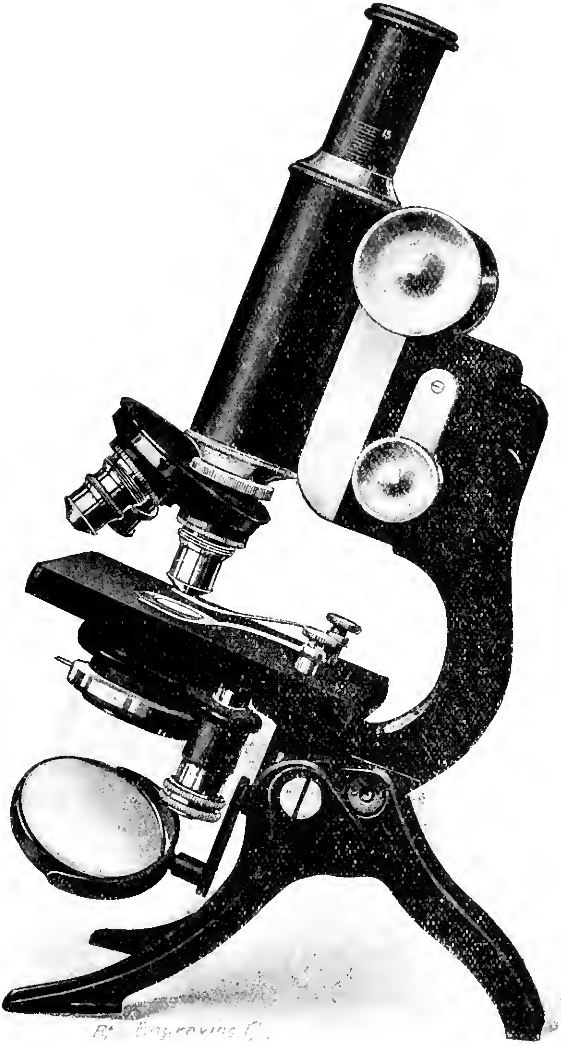


Fig. 3.

The method of working is as follows. Assuming that it is desired to check a scale at intervals of 100 mm., the Microscopes are focused on a standard scale and the interval between them is adjusted by hand to be as nearly as possible 100 mm. Experience shows that this interval can be adjusted correctly to within 0·1 mm. To determine the exact interval, the cross wires in the left-hand Microscope are brought into coincidence with one of the marks defining the standard scale and the reading of the micrometer head noted. The head is then turned till the cross wires of the right-hand Microscope are on the other mark, and the reading again taken. The exact distance between the points on which the Microscopes are focused is thus known. The calibration of a scale may be tested by a series of observations made in a similar manner.

If desired a micrometer eye-piece with head divided to 0·01 mm. can be fitted to one of the Microscopes. It will be found that this very much facilitates quick adjustment of the instrument.

New Spencer Portable Microscope.*—This instrument, which is listed as No. 60 in the maker's catalogue, is shown in fig. 3. It is

Fig. 4.

enclosed in a metal case (fig. 4), the two halves of which are hinged together. Each half is a single thin casting of magnalium, a light alloy of aluminium which is resistant to weather conditions. The wall is strengthened around the edge by a narrow band of increased thickness which is sufficient for holding a felt buffer to make the case dust-tight. This buffer is burnished into the metal. No glue is used to fasten any of the pads. The outside is finished in an imitation leather enamel, which is baked on and is permanent. This, together with the rounded

* Spencer Microscopes and Accessories, 1914, p. 54. Buffalo, New York, and 83 Wigmore Street, London, W.

edges and corners, makes an exceptionally neat case, $8\frac{3}{4}$ in. by $6\frac{1}{2}$ in. by $3\frac{3}{4}$ in. in its extreme over-all dimensions. The Microscope is rigidly held in place in the case by two strong pins, which fit into depressions in the arm. To prepare for using, it is only necessary to lift the instrument from the case, turn the legs to position and pull the draw-tube. The instrument goes into the case with the objectives in position on the nose-piece. Caps are furnished for protecting the objectives if desired. The instrument, a simple side fine adjustment, each division of the

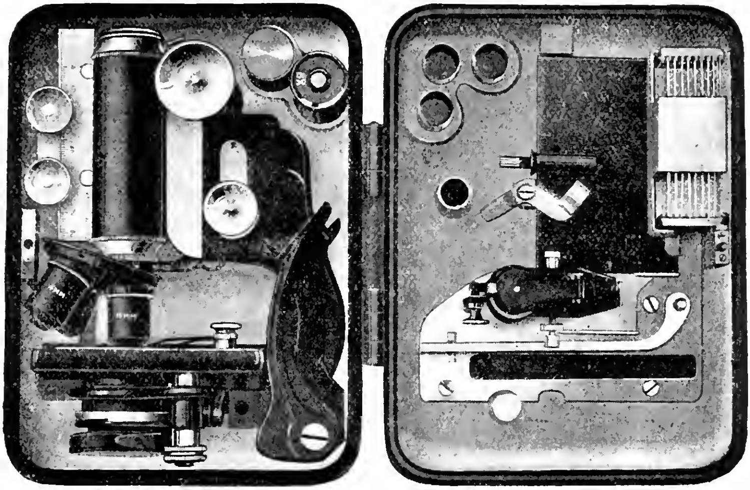


Fig. 5.

graduated button of which represents a movement of one micron in the body tube. Fig. 5 shows the open case, the mechanical stage and camera-lucida being in position.

(4) Photomicrography.

Freedom from Vibration for Photomicrography.*—The apparatus described below has been in use in the Office of Soil Bacteriology Investigations for many years, and has made it possible, says K. F. Kellerman, to prepare photomicrographs of unusually high character, requiring sometimes as much as six minutes exposure, even though tram cars and heavy wagons pass the doorway of our building at frequent intervals. The stand consists essentially of a heavy stone slab A, upon which is mounted the photomicrographic equipment and the electric lighting apparatus. Immediately below this stone and supporting it is

* Dep. Agric. U.S.A., Bureau of Plant Industry.

a layer of felt B, approximately 2 in. in thickness. This felt layer is in effect a shock absorber. The felt in turn is supported by the flat top of the movable table C. This table may be equipped with cupboards and drawers giving the necessary space for the special equipment for the various kinds of photomicrography which may be attempted. At the corners of the table near the wheels, where castors are placed, there are also placed spring checks D, which can be adjusted to press against the floor and thus prevent any undue freedom of movement of the table while it is in use. Examples of six-minute exposures, at 1000 magnification, are extremely fine.

(5) Microscopical Optics and Manipulation.

Optic Projection by S. H. and H. P. Gage.*—This book is a very complete and up to date exposition of its subject. The authors' intention is not only to give an explanation of the principles underlying the art, but to give such simple and explicit directions that any intelligent person can succeed in all the fields of projection. At the same time attention is devoted to the physiological principles of vision, so that the investigator in novel or special applications of projection may have a clear idea of the methods which must be adopted to obtain success While impressed with the general excellence of the apparatus supplied by many different makers, the authors point out certain general defects, among them being an uncertainty as to the right and the wrong way of using the auxiliary parts of an apparatus. The authors think that manufacturers should give attention to this point, and should construct their apparatus so that it can be used in only one, and that the right way. Thus, to take a simple example, the condenser is usually so mounted that it may be used with either end facing the arc lamp: this ought to be impossible, and could be easily obviated. This idea of rendering the apparatus as far as possible "fool-proof" is a strong feature of the book. Every chapter is followed by a summary of useful instructions, entitled "Do" and "Do not," with the intention of reducing the difficulties of operators.

The work is divided into fifteen chapters, the first six of which deal with the magic-lantern as operated with different kinds of light (direct current, alternating current, house electric light, lime-light, ordinary lamps, and sunlight). Other chapters deal with projection of opaque objects, lantern slides, the projection Microscope, drawing and photography with projection apparatus, moving pictures. Chapter XII is a useful discussion of projection rooms and screens. Chapters XIII and XIV treat of electric currents and their measurements, and optics of projection: and Chapter XV discusses normal and defective vision. An appendix gives a brief historical statement on the origin and development of projection apparatus. There are modern and historical bibliographies and a list of manufacturers of projection apparatus.

* Comstock Publishing Co., Ithaca, New York (1914) 731 pp. (413 figs.).

(6) Miscellaneous.

Batsch's "Testacea Arenulæ," 1791.*—E. Heron-Allen informs us that by the courtesy of F. W. Millet, F.R.M.S., he has been informed of yet another copy of this ultra-rare work, which is in that gentleman's possession. As this newly recorded copy is said to contain both the Latin and German versions of the text, it would also appear to be unique, for no such edition has ever been recorded before.

Apparatus and Practical Methods for the Microscopical Examination of Crystalline Bodies.†—This work is divided into five parts and is published as a supplement to Mikrokosmos. Its object is to deal exhaustively with the subject of micro-crystallography in such a manner as to meet the needs of amateurs and of all classes of investigators. The first three parts are due to C. Leiss, and deal with petrological Microscopes and the various instruments and methods in general use for preparing objects. The last part contains two sub-parts and is by H. Schneiderhöhn: it sets forth the methods of investigation in systematic order. The titles of the parts are:—

1. Structure and manipulation of the mineralogical Microscope and its auxiliary apparatus (32 pp.).
2. Management of rock-preparations and their sections (5 pp.)
3. Apparatus for determination of optical constants of crystalline bodies (4 pp).
4. Determination of physical constants of crystalline bodies by means of the polarizing Microscope:—(*a*) transparent objects (46 pp.); (*b*) opaque objects (5 pp.). The work also contains a bibliography of modern authorities.

B. Technique.‡

(1) Collecting Objects, including Culture Processes.

Pipette Method in the Isolation of Single Micro-organisms.§ In this communication, M. A. Barber has collected together the various descriptions which have appeared from time to time regarding the technique and methods of application of the pipette method of isolating single micro-organisms under microscopical control. He has also

* See this Journal, 1914, p. 526.

† Apparate und Arbeitsmethoden zur mikroskopischen Untersuchung Kristallisierter-Körper. C. Leiss and H. Schneiderhöhn. Stuttgart: "Mikrokosmos" (1914) 94 pp. (115 figs.).

‡ This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Embedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, etc.; (6) Miscellaneous.

§ Philippine Journ. Sci., ix. (1914) pp. 307–60 (19 figs. and 2 pls.).

appended considerable information not before published regarding the various applications of the method. The technique has a very wide application, not only in bacteriology but also in all departments of microscopy. Single bacteria, yeast-cells, spores of fungi, algæ, protozoa, blood-corpuscles, and other histological elements may be isolated with comparative ease. Isolated organisms may be cultivated *in situ*, transferred to any medium, or inoculated into animals Injections may be made into the vacuoles or protoplasm of living cells. Microscopical

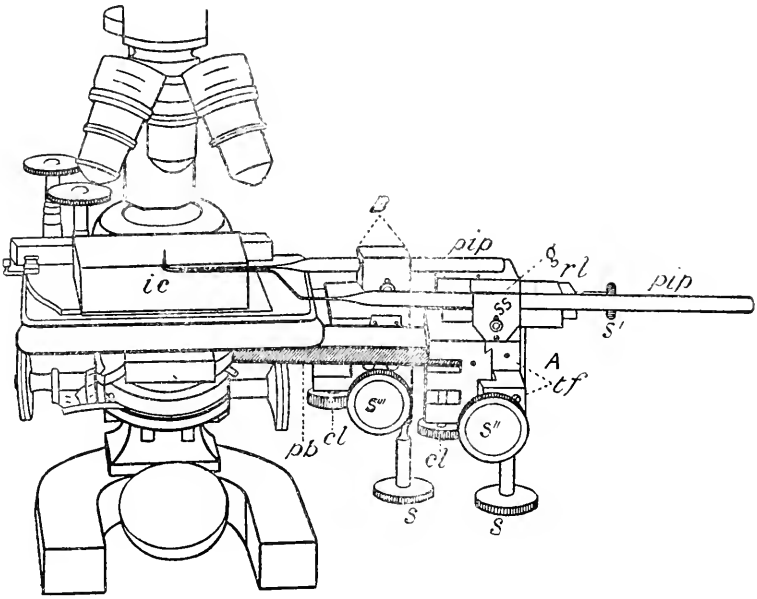


FIG. 6.—Microscope with two pipette-holders, each containing a pipette attached to the stage by means of metal plates. Seen from the back: A a three-movement, and B a two-movement holder; *tf*, adjustment governed by screen *s''* for moving the pipette to and from the observer.

objects may be dissected or stained under the highest powers of the Microscope.

The principle of the method consists in the separation of a single organism by means of a very finely-pointed capillary glass pipette. The isolation is carried out in hanging drops on the under-side of a large cover-glass, which is placed over a moist chamber. The organism to be isolated is touched with the tip of the pipette, into which it enters by capillarity; a sterile portion of the cover-glass is brought over the tip and the organism is discharged on to it by pressure through a rubber tube held in the mouth of the operator. The whole process is carried out under the Microscope, with the highest powers, if desired.

Various methods of procedure are applicable. The most convenient is that in which the pipette is manipulated by means of a special holder, clamped directly on to the Microscope stage, or to a metal plate fastened beneath. The best form of pipette-holder possesses movements in three directions of space as shown in fig. 6. The figure also shows the other portions of the apparatus in position. The pipette is held in a groove *g* in the side of the adjustment *rl* and is fixed by the set screw *ss*.

The moist chamber (fig. 7) is made by fastening strips of glass to a slide with Canada balsam or any convenient cement, an additional strip being cemented to the slide at the open end *s*, which serves to strengthen the apparatus and makes it capable of holding water. A convenient size for the moist chamber is 70 mm. long, 35 wide, and 28 high. The moist chamber is lined on the sides and end with filter paper, *p*, in order to furnish a large moist surface. The cover glass, which should be of a sufficient size to seal well over the sides of the chamber, needs special care in its preparation. After careful cleaning, a little vaseline is applied, the excess of vaseline is removed with soap and water, and the

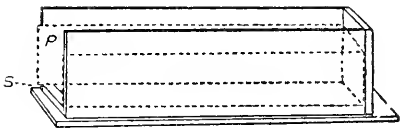


FIG. 7.—Isolating chamber. *p*, lining of blotting-paper: *s*, glass strip for retaining water in bottom.

cover-glass, after warming, is rubbed with a dry clean cloth. The trace of vaseline left behind is sufficient to prevent the hanging drops from running together. Before use the cover-glass is sterilized, and a series of drops of sterile broth are placed on the under side.

The making of the capillary pipette presents some difficulties, and experience is needed to obtain the best results. An ordinary capillary pipette (0·5 mm. external diameter) is first drawn out in the Bunsen flame. The shank of the pipette is held in the right hand, and with a pair of fine forceps held in the left hand, the capillary is grasped at about 5 cm. from the shank, both hands resting on the table. The point of the capillary next to the forceps is then held over the flame of a micro-burner (fig. 8). When the glass begins to soften it is lifted slowly from the flame and pulled so as to draw the capillary out into a very fine point. The end of the capillary is then turned at right angles. The pipette is placed in position in the pipette holder, and the tip brought into view, and into the centre of the field of the Microscope by means of the adjustments. The tip is then lowered. One of the drops of sterile broth is then brought into the field, the objective is lowered until the tip comes into view and the objective and tip are then raised together until the tip comes into contact with the cover-glass just outside the drop. The point of the capillary is then broken against the cover-glass,

and a little broth taken up by suction on the rubber tube held in the mouth. If the point is sufficiently patent, a little drop should be easily blown out on to the cover-glass. The size of the opening will vary with the nature of the work in contemplation. If too large, say over 15 micrometers, the difficulty of isolation will increase; if too small, say less than a micrometer, it will be difficult to blow out broth or introduce the larger bacteria. Bacteria can be isolated by means of the high powers. The tip is brought into the drop near the bacterium and is then lowered, the bacterium usually entering the pipette by capillarity. It can be isolated on a sterile part of the cover-glass. In using cover-glass

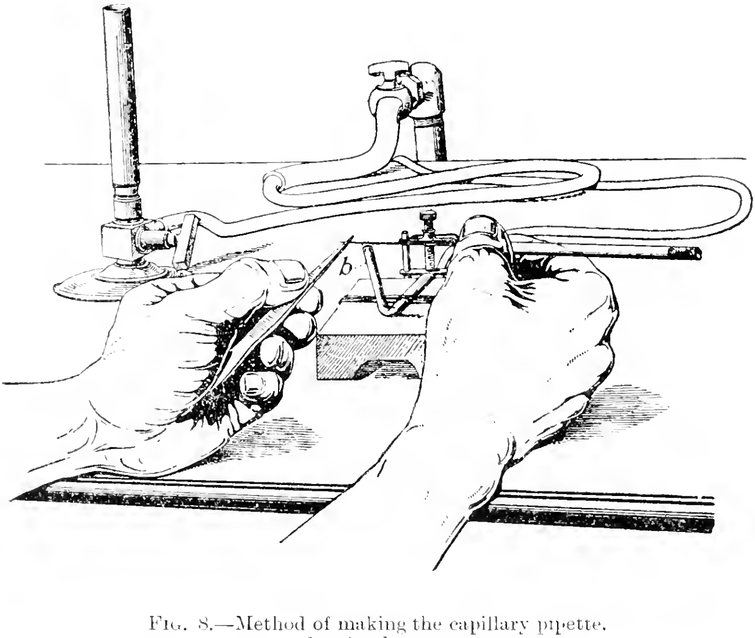


FIG. 8.—Method of making the capillary pipette.
b, microburner.

cultivations, broth, liquefied gelatin, or any fluid or semi-fluid, may be employed. The media may be placed in readiness on the slide previous to isolation.

The isolated organisms may be inoculated into animals, subcutaneously, intravenously, or intraperitoneally. The organism is washed well back into the pipette with broth or salt solution. The end of the pipette (which should be obliquely fractured) is inserted into the tissue of the animal and the organism blown out. Large animals may be inoculated through the mucous membrane of the mouth.

In the latter portion of his paper Barber gives full details of the various special applications of the pipette method that he has employed

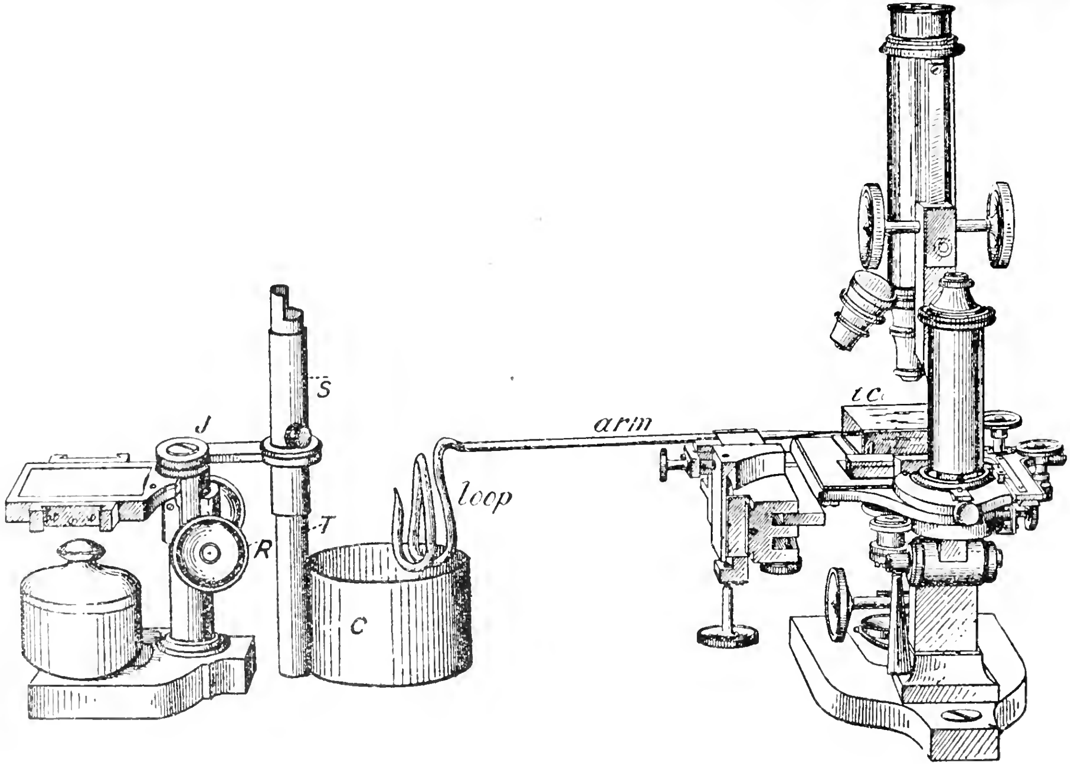


FIG. 9. The inoculation pipette in position, with the apparatus for regulating the temperature of the loop. R, ratchet and pinion of a simple Microscope; S, sleeve of metal fastened to the lens-holder, which is joined to the Microscope at J; T, hollow metal tube inserted in the sleeve, and bearing at its base the cup C.

from time to time. These include the carrying out of serological tests, experiments on chemiotaxis, dissections and inoculations into living cells. A special form of pipette is needed for the latter purpose. Either hard or soft glass may be used. A piece of tubing about 35 cm. long is bent at one end into the form shown in fig. 9. The tip of the convoluted portion is drawn out into a coarse capillary, inserted into a cup of mercury, and filled by exhausting the tube at the straight end, the tube being heated before filling; the aperture is then sealed off. The end of the arm is next drawn out into a straight capillary about 8 cm. long and 0·5 to 0·8 mm. external diameter. The pipette is then filled with mercury to the tip of the capillary, the loop being gently heated and the tip immersed in mercury. The mercury in the capillary is then retracted by immersing the loop in ice water, and the pipette point made in the micro-burner in the usual way. A special form of apparatus is needed for the regulation of the temperature of the loop (see fig. 9). The cup *c*, containing ice and water, can be raised or lowered by means of ratchet and pinion, or swung aside. The inoculating substance is introduced into the capillary tip by raising the cup and thus lowering the temperature of the mercury. The tip is then inserted into the cell selected for inoculation, and the mercury in the loop expanded by lowering the cup containing the ice-water; the inoculating substance being driven out by pressure into the substance of the cell body.

Diagnosis of Asiatic Cholera.*—B. C. Cromwell has investigated a series of cases post mortem, with the view of ascertaining how far cholera can be diagnosed from the gross pathological lesions without having recourse to bacteriological examination. Ninety-two cases were examined in all, and while it was ascertained that no anatomical feature was in constant evidence, a diagnosis of cholera might be based on the following features:—Acute catarrhal enteritis associated with (1) cyanotic finger nails; (2) dry tissues; (3) oligæmia; (4) dry and sticky peritoneum, with pink serosa of the ileum; (5) contracted and empty urinary bladder; (6) shrunken, dry spleen and liver; (7) acute degeneration of parenchymatous organs; (8) poorly coagulated blood; (9) absence of formed fæces; (10) presence of "rice water stools"; and (11) prominence of lymphoid tissue in the ileum. Comparison of anatomical and bacteriological findings led to an identity of diagnosis in eighty-seven cases. Five cases anatomically negative were proved to be positive on bacteriological examination.

(3) Cutting, including Embedding and Microtomes.

New Spencer Rotary Microtome.†—The Spencer Lens Co. have set themselves to remedy the defect usually found in rotary microtomes, viz., want of accuracy in cutting, one after another, sections of definite uniform thickness. They claim to have accomplished this by making

* Philippine Journ. Sci., ix. (1914) pp. 361–5.
† Special Pamphlet, Spencer Lens Co., Buffalo, New York.

the sliding part S P (fig. 10), into which the object-clamp fits, move freely backward and forward in B, its polished inclined surface being firmly held by a spring against the point P which, in turn, is firmly sup-supported on the slideway forming a part of the feed-mechanism, which again, in turn, is independent of the up-and-down movement. This is contrary to most microtomes, as in the majority of them the feed-mechanism is dependent on the up-and-down movement, with the result that sooner or later inequality of section-cutting results. In the Spencer

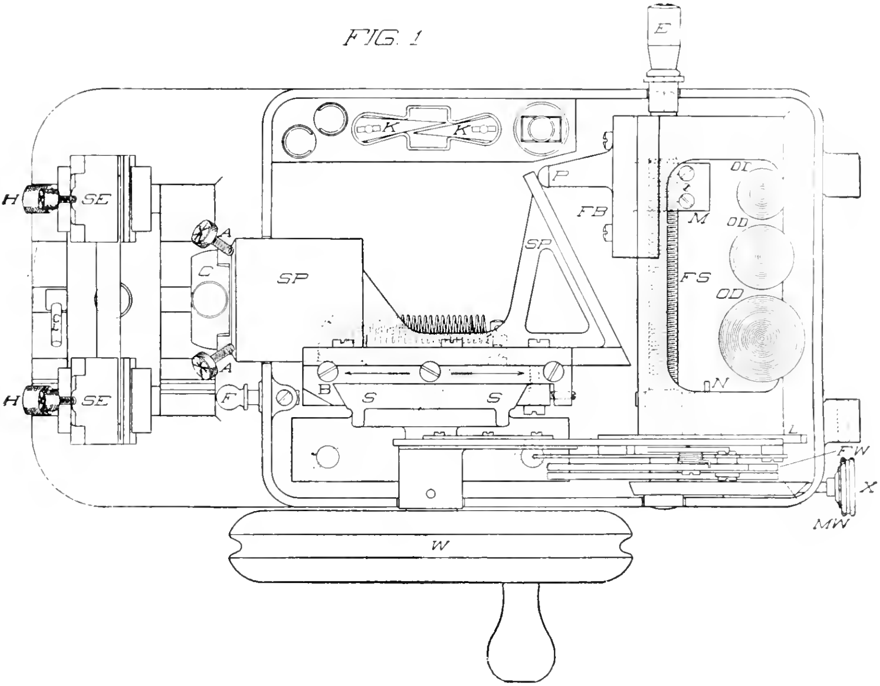


Fig. 10.

machine the feed-mechanism is composed of a rigid bearing on which the feed-block F B, of which the point P is a part, is moved by the feed-screw F S. As this block is moved towards the side on which the balance wheel W is located, the sliding part S P is forced forward towards the knife one half as much, because the polished surface resting against the point P is set at the proper angle to accomplished this purpose. Thus any imperfection in the screw is reduced by one half. As the screw is cut with two threads to the millimetre and as it is revolved by a ratchet feed-wheel with 250 teeth, each tooth represents a feeding of the object forward one micron. The feed is so arranged that it can be set for

sections of any thickness, from one micron to sixty microns, by turning the knurled button at the back of the case, just below the hinge, until the number representing the desired thickness appears opposite the indicator I (fig. 11) at the small opening in the side of the case near the balance-wheel. The total excursion of the feed is 37 mm., allowing a sufficient range for cutting a complete series of a very large object without the necessity of a break in the series, due to resetting the knife and the feeding-mechanism. The pawl F P (fig. 11). which works into the teeth of the feed ratchet-wheel F W (fig. 10) is located at the end of an arm F A (fig. 11). which swings on an axis identical with that of the screw. This arm is actuated by a connecting arm C A (fig. 11) running from

FIG. 2

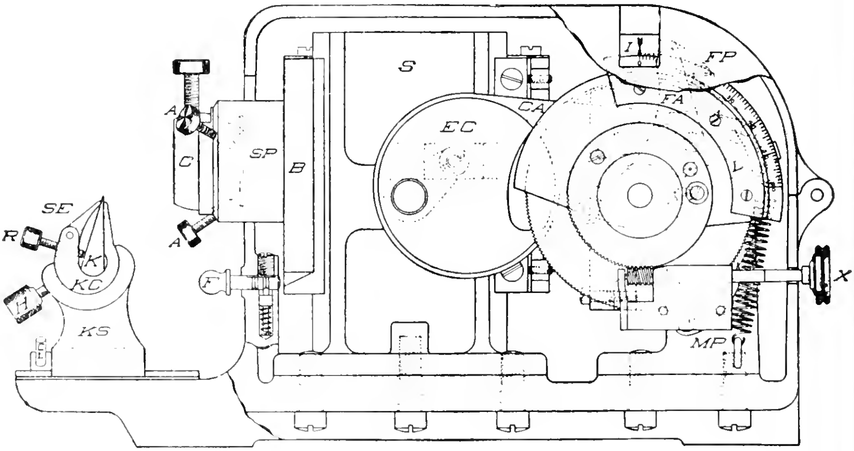


FIG. 11.

it to an excentric E C (fig. 11), which revolves with the balance-wheel W. This excentric is so located on the axis that the feeding is done when the object is at its upper limit and thus above the knife. thereby avoiding the danger of forcing the face of the paraffin against the knife on the upward stroke.

By the side of the feeding ratchet-wheel there is another ratchet-wheel M W (fig. 10) like it, but placed with the teeth running in the opposite direction. Working into the teeth of this wheel is a pawl M P (fig. 11) fastened to the upright support of the sliding bearing of the feed block F B. This pawl is kept away from the teeth of its rachet-wheel by a cam fastened to the arm carrying the feed pawl, and is allowed to engage the teeth only for an instant at the extreme end of the feeding stroke. This brings the wheels and feed screw to a definite

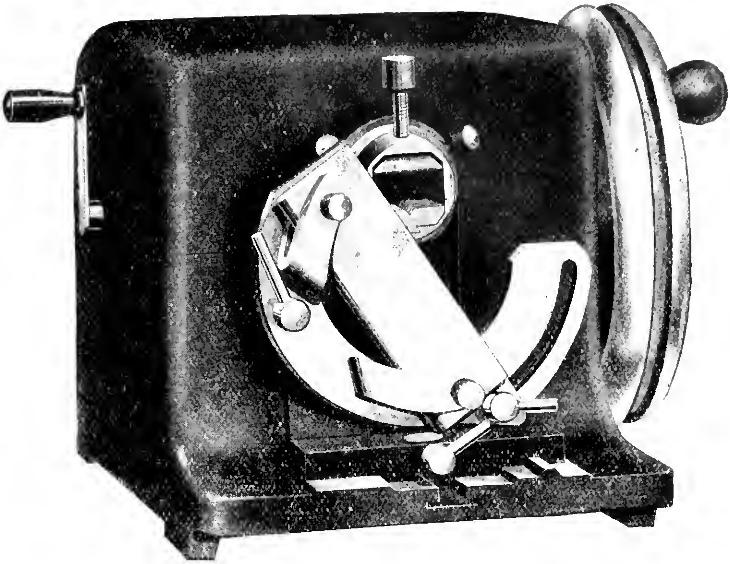


Fig. 12.

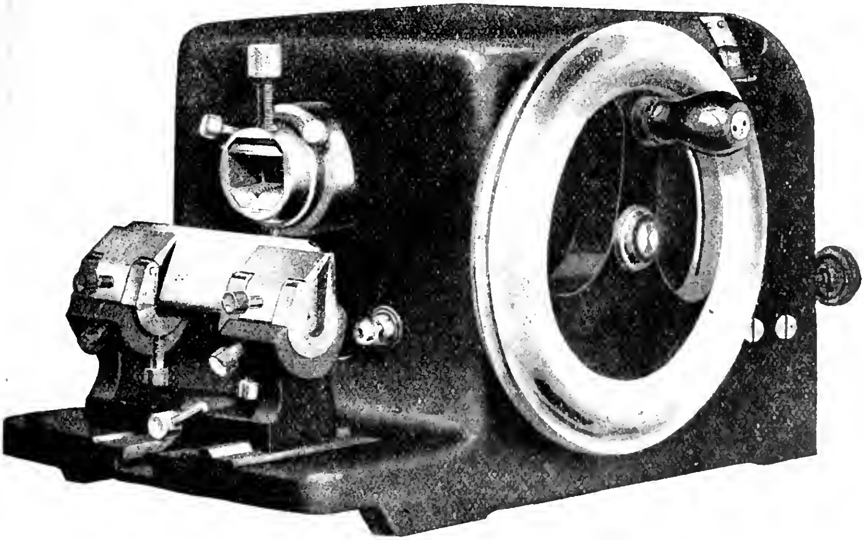


Fig. 13.

stop overcoming momentum and always ensuring sections of exactly the thickness called for; which is, of course, a very essential feature. The feed pawl is automatically lifted free from the teeth of its ratchet-wheel on the return stroke, thus avoiding wear and the accompanying noise. There are special arrangements for avoiding injury to thread of feed when the nut has reached its limit and for resumption of cutting. The up-and-down stroke of the object clamp is 2 in. The whole of the feeding mechanism is covered thus protecting the wearing parts from dust, and presenting a much neater apparatus (figs. 12, 13).

New Spencer Cylindrical Ribbon-carrier.*—This apparatus, which is shown in fig. 14, has been made after C. E. McClung. The

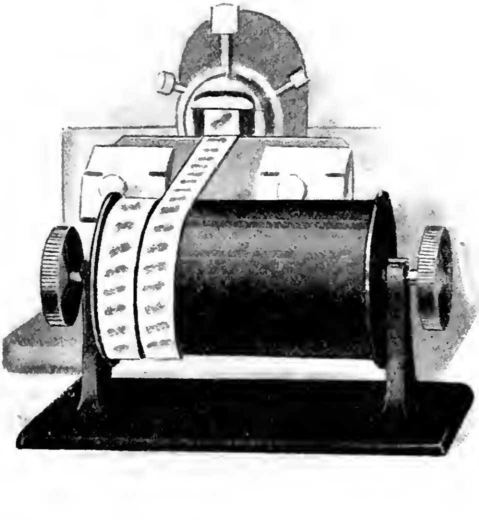


Fig. 14.

aluminium cylinder is mounted in an aluminium framework, under the base of which are little rollers rotating in the direction of the long dimension of the frame. The end of the ribbon adheres to the cylinder, which is slowly turned by the little buttons at the end as the ribbon lengthens. At the same time the cylinder and frame are gently pushed forward on the recess so as to place the ribbon on the cylinder in a long spiral. The cylinder is $4\frac{1}{2}$ in. long and $2\frac{5}{8}$ in. in diameter.

* Spencer Microscopes and Accessories, 1914. Buffalo, New York, and 83 Wigmore Street, London, W.

(4) Staining and Injecting.

Method of Staining Parasitic Amœbæ.*—The difficulty of satisfactorily staining the amœbæ of dysentery and allied forms is in practice considerable, so that any method which can be relied on to give good results is of interest. The following directions are given in a recent communication by Alexander Marshall, of the Wellcome Tropical Research Laboratories at Khartoum. Smears are made from dysenteric stools and transferred rapidly, while still wet, to Schaudinn's fluid. They are then washed in alcohol of different strengths and finally in distilled water, after which they are stained in Delafield's hæmatoxylin for twenty minutes. They are next washed in tap water and stained with carbol-fuchsin, as for tubercle bacilli; after which they are again washed with water and finally differentiated with Sprengel's solution of picric acid, consisting of equal parts of absolute alcohol and of saturated watery solution of the acid. This is applied for three to five minutes, during which time the reagent is changed three or four times. The stained films are then dehydrated in absolute alcohol, cleared in xylol, and mounted in Canada balsam. Thus treated, the nuclei of the parasites are stained a purplish black, while the cytoplasm is a pale translucent yellow colour. Red blood corpuscles are also stained yellow. The method is described as easy, rapid, and certain in its results, and is certainly well worth trial by those called upon to make this investigation.

Cytology of the Stamens of Smilax herbacea.†—Lilian E. Humphrey carried out an investigation, the primary purpose of which was to observe the reduction division in the microsporocytes of *Smilax herbacea*. The buds were killed in Schaffner's weaker chrom-acetic acid and with a trace of osmic acid added, being left in this for twenty-four hours. After being thoroughly washed in water, the material was dehydrated by passing it through the various grades of alcohol to 70 p.c., where it was left for about three months, when it was passed through the higher grades into chloroform, from which it was gradually passed into pure paraffin and embedded. Sections 10μ to 13μ thick were cut.

Several methods of staining were used. The first tried was anilin-safranin, which was a fairly good stain, but it did not make enough differentiation between the chromatin material and the cytoplasm to be easily studied. Next Heidenhain's iron-alum-hæmatoxylin was used and found to be very good, staining the chromatin material black and the surrounding tissues brownish. In using this stain the slides were passed through turpentine, xylol, the different grades of alcohol to water, then passed through iron-alum, where they were left for two hours; after being well washed in water, they were left four hours or longer in

* Lancet (1915) i. p. 145.
† Ohio Naturalist, xv. (1914) pp. 357–67 (2 pls.).

Heidenhain's hæmatoxylin, after which they were washed and placed in iron-alum to clear, and after dehydration they were mounted in Canada balsam. The most satisfactory stain was Delafield's hæmatoxylin. The slides were passed through alcohols to 25 p.c., then into Delafield, where they were left for two hours, after which they were washed in water and passed up through the alcohols and mounted.

Metallography, etc.

Metallography of German Silver.*—F. C. Thompson has studied the microstructure of commercial specimens of German silver, consisting of the α solid solution of the copper-zinc-nickel system. In one series of experiments four melts of identical composition were made. To one was added 0·25 p.c. manganese, to another 0·5 p.c. aluminium; while no addition was made to the remaining two. The alloys after casting were rolled into sheets and annealed. The mean area of the crystals of the two alloys which had not been deoxidized was 0·3 sq. cm., while the mean crystal-area of the alloys deoxidized respectively with manganese and with aluminium was 0·0005 sq. cm. The manganese had passed almost wholly into the slag, hardly a trace remaining in the alloy. A specimen of high nickel content, after annealing at an excessively high temperature, was found to have a very definite "casting" structure. It was then annealed at 750° C. for four hours. The structure after this treatment was normal, and all traces of the dendritic markings had disappeared. The specimen was next reheated to about 1000° C. for one hour: this caused the reappearance of the casting pattern. Th author believes that the casting pattern, reproduced by overheating previously annealed alloys,, is a remnant of the structure of the original ingot, but so faintly preserved that in ordinary circumstances it is not seen. Its reappearance may be due to incipient volatilization of zinc occurring at high temperatures. An overheated specimen showed almost complete absence of twin crystals. A series of seven alloys ranging in nickel content from 7 to 22 p.c. were submitted to ordinary commercial treatment. The size of the crystals diminished notably with increasing nickel content, the mean crystal-area being 0·015 sq. cm. in the alloy containing 12 p.c. nickel, and 0·0005 sq. cm. in the alloy containing 22 p.c. nickel. The sections were etched with 5 p.c. ferric chloride solution.

Artificial Twin-crystals in Tin.†—The crystals of a block of tin affected by stresses may contain twinned lamellæ; these become apparent in an artificially-polished surface etched with hydrochloric acid. P. Gaubert has studied the formation of the twin-crystals in the following manner. A few grammes of tin were melted between clean plane glass surfaces. By pressing the upper glass plate, the layer of tin could be brought to the desired thickness. On solidification a plate of tin was obtained with plane surfaces having a perfect polish. By controlling the rate of cooling during solidification, the crystals could be obtained

* Journ. Chem. Soc., cv. (1914) pp. 2342–9 (7 figs.).
† Comptes Rendus, clix. (1914) pp. 680–2.

of any desired size, up to the whole area of the specimen, which then consisted of one crystal. Striking such a plate of tin with the point of a needle produced: (1) on the face opposite to the face penetrated, a cross in relief, with broad arms; (2) two or three series of bright bands, parallel, of width up to 0·5 mm., and reaching from the impression made by the needle, to the boundary of the crystal. These twinned lamellæ passed right through the crystal. Their faces, originally in the same plane as the general surface of the plate, now formed an angle of several degrees with it. Further phenomena observed are described. The "cry" of tin appears to be caused by the formation of twinned crystals.

Dilute Solutions of Aluminium in Gold.*—C. T. Heycock and F. H. Neville have determined the equilibrium diagram of the aluminium-gold system for the range 0 to 5 p.c. aluminium, and describe the microstructure of the numerous alloys examined. From 0 to 2 p.c. aluminium the α solid solution only was found. From 2 to 3 p.c. the alloys consisted of α and β, β being stable only above 424° C. A substance D may be the compound Al_3Au_8. Polished and etched surfaces of β that have been chilled at a high temperature show, under high magnification, groups of fine parallel lines, the direction of the lines changing from grain to grain so as to give the effect of shading. This is due to a laminated structure in the β, perhaps to an incipient decomposition. When β is slowly cooled it breaks up at 424° C. (the eutectoid temperature) into a complex of α and of D. The etching reagents used were bromine water and aqua regia; the two gave practically the same pattern.

Nitrogen in Steel.†—A peculiar structure found in the welded portions of electrically-welded iron plates led B. Strauss to undertake an investigation upon nitrogen in steel. These welded portions contained up to 0·12 p.c. nitrogen, while plates welded by means of acetylene contained 0·02 p.c. nitrogen. The nitrification of iron specimens in a current of ammonia gas begins below 300° C., and proceeds most rapidly between 600° and 800° C. In this way are obtained layers differing in nitrogen content and in structure. The outermost layer of a nitrified specimen of pure iron consisted of the nitride Fe_4N_2. Below this was a layer, having a pearlite-like structure, in which both carbon and nitrogen were present, the carbon being obtained from pyridine, an impurity in the ammonia used. The next layer had an acicular structure, which was also present in the electrically-welded plates. The needles, formerly regarded as consisting of an iron-nitride, were found to be twinned lamellæ in the nitrogen-containing ferrite crystals. When carbon steels were nitrified, another constituent, appearing as light brown specks in the etched specimens, was formed. The iron nitride was readily decomposed by heating: when elements such as silicon

* Phil. Trans., Series A, ccxiv. (1914) pp. 267–76 (26 figs.).
† Stahl und Eisen, xxxiv. (1914) pp. 1055–6.

and chromium were also present, nitrification at higher temperatures caused the formation of the nitrides of these elements, these nitrides being more stable than iron-nitride. Heat-tinting was employed to distinguish the constituents, since the nitrogen-containing constituents oxidized more rapidly than the carbide or the ferrite. Lumière autochrome photomicrographs preserved a record of the heat-tinted specimens in their actual colours.

Decarburization of Steels in Salt Baths.*—A. M. Portevin describes experiments indicating the considerable extent of the decarburization of surface layers which may occur in steel objects during heating in salt baths previous to hardening. When cyanides are present in the salt bath, the carbon-content of a low-carbon steel may be increased, that of a high-carbon steel diminished, by immersion. In iron, originally carbon-free, which had become superficially carburized through heating in a salt bath containing cyanides, there were observed microscopically, in the ferrite below the carburized layer, needles resembling those seen in specimens of steel suspected to contain much nitrogen.

Heat-treatment of Steel Wire.†—In the course of manufacture, steel wire undergoes heat-treatments which vary according to the composition of the steel and the purpose for which the wire is intended. J. F. Tinsley describes and explains the effect of such treatments on microstructure. The principal heat-treatments are: (1) annealing; (2) "patenting"; and (3) hardening and tempering. Annealing is employed to effect one or more of three results: (*a*) to remove cold-work effects; (*b*) to refine the crystalline structure; (*c*) to produce some desired structure such as granular pearlite. To remove cold-work effects it is not necessary to heat above the critical range; 600° C. is a sufficiently high temperature. "Patenting" consists in heating above the critical range and cooling rapidly to a temperature below the critical range, as by immersion in molten lead. The structure produced is sorbitic. Hardening and tempering are usually conducted as a continuous operation, the wire passing from the furnace, through a quenching bath of oil or water, and then through a tempering bath such as molten lead.

Theory of Hardening and Constitution of Steel.‡—In some remarks introductory to a discussion of the constitution of steel, E. D. Campbell states that in a steel containing 0·32 p.c. carbon, cooled from 1060° to 700° C. in seven hours, the carbide areas were sharply separated, and were 0·2 to 0·3 mm. in size, embedded in nearly pure ferrite, the

* Journ. Iron and Steel Inst., xc. (1914, 2) pp. 196–203 (2 figs.).
† Iron and Coal Trades Review, lxxxviii. (1914) pp. 948–50 (8 figs.).
‡ Journ. Iron and Steel Inst., xc. (1914, 2) pp. 1–16.

distance between individual carbide areas being somewhat greater than their diameters. The author's experience suggests that, in steel annealed in this way, at least an hour at 1000° C. is required for precipitated carbides to redissolve and diffuse so that a strictly homogeneous solid solution in chemical equilibrium is obtained.

PROCEEDINGS OF THE SOCIETY.

MEETING

Held on the 16th December, 1914, at 20 Hanover Square, W., Mr. E. Heron-Allen, F.L.S. F.G.S., etc., Vice-President, in the Chair.

The Minutes of the Meeting of November 18, 1914, were read, and, when confirmed, were signed by the Chairman.

Mr. J. E. Barnard gave a lecture on "The X-rays in Relation to the Microscope," which he elucidated both by apparatus and by diagrams. Illustrations of his photographic work on the Foraminifera by X-ray methods were thrown on the screen, and the specimens described by Mr. Arthur Earland.

At the close of Mr. Barnard's communication,

The Chairman (Mr. Heron-Allen) said: Mr. Barnard has been good enough to furnish me with a duplicate set of the slides of Foraminifera which he has exhibited, and to discuss with me his views upon the questions involved in the very remarkable demonstration which he has given us this evening. I am much indebted to him, because it has given me an opportunity of considering the matter more carefully than is possible had I come fresh to it at this Meeting; and on an occasion so important as this is it behoves one to weigh carefully what he says in commenting upon the paper. I feel that this is the more important because I think it is more than likely that some day the recorded minutes of this Meeting will be referred to by students as marking the commencement of a new era in the history of biological research. I have no hesitation in saying, and I say it with a full sense of the responsibility which I incur, that during the period (now close upon a quarter of a century) in which I have been a Fellow of this Society, and have read its Proceedings when I have not been able to attend its Meetings, the communication of Mr. Barnard this evening is by far the most weighty pronouncement that has been made before the Society. I will even go so far as to say that the ultimate goal which thoughtful biologists (endowed with that quality of imagination which Tyndall, Huxley, Lankester, and others have described as an indispensable factor in the equipment of a biological researcher) must foreshadow as a result of Mr. Barnard's work, may be of an importance standing hardly second to the discovery of the circulation of the blood.

The importance of the results of Mr. Barnard's manipulative skill divides itself clearly and at once under three heads. First, the practical value of this method of examination to the pure systematist in the determination of species. I understand that at present the expense of the apparatus required is very great, but experience teaches us that this is a matter which is likely to be solved by time, and that this is a difficulty which will yield to the imperative laws of demand.

We have seen demonstrated the internal structure of a foraminiferal test which has defied the usual methods of transparent mounting and critical illumination, and systematic zoologists will readily recognize the paramount value of a method which enables them to diagnose the internal structure of an organism of which, as frequently happens, only a single specimen is forthcoming—a structure which otherwise cannot be ascertained without the intervention of an exploratory operation which, in common with some other exploratory operations, occasionally destroys the patient.

Second, by the methods which Mr. Barnard has put before us the study of the bionomics of those Protozoa which, like the Foraminifera, are enclosed in an opaque shell, is for the first time rendered easy—I may say for the first time rendered possible. When we set out to study by experiments a biological problem in the case of such organisms, our only chance of arriving at a result has hitherto been to gauge, as nearly as we can, the moment at which the phenomenon has taken place inside the test, and then to kill the animal and ascertain the progress of the experiment or its result, by the extremely difficult and dangerous process of decalcifying the organism and mounting the protoplasmic body in some transparent medium. From an examination of the internal structure of a dead shell such as Mr. Barnard has demonstrated to us, to the examination of that shell in the living condition is but a step, a long step perhaps, but one which we may confidently rely upon such expert manipulators as Mr. Barnard to take when the need shall arise. We shall then be able to observe, without killing the animal, the progress of many phenomena that have engaged the attention of rhizopodists, and to find answers to questions which have hitherto defied any solution that is not purely conjectural. To mention only one or two of such problems, we may refer to the phenomenon of the absorption of the internal septa in many genera, as for instance in the genus Polymorphina which so long ago as 1883, engaged the attention of the late Dr. Alcock,* and comparatively lately of Mr. Henry Sidebottom,† and the formation of polythalamous young already invested with a calcareous test inside the parent shell, as recorded by Earland in 1905, and by us jointly on several subsequent occasions.‡ We may not unreasonably look forward to the elucidation by Mr. Barnard's method of the problem of the growth of monothalamous arenaceous shells. I see no reason for doubting that this process is one parallel to that described by Professor Max Verworn and Professor Minchin in the case of the fresh-water Rhizopoda

* Proc. Lit. and Phil. Soc. Manchester, xxii. (1883) p. 67.

† Proc. Lit. and Phil. Soc. Manchester (1907) No. 9, p. 17.

‡ Journ. Quekett Micr. Club, ser. 2, ix. (1905) p. 222. See also Proc. R. Irish Acad., xxxi. (1913) pt. 64, p. 119.

Difflugia and *Euglypha*, who have shown that foreign particles are drawn into the interior of the protoplasmic body and stored in the fundus of the shell, and are used, as necessity arises, in the growth or repair of the shell,* a theory which we expounded in our paper read before the British Association in 1913, and published in the Journal of this Society.† The soundness of these deductions is brought within a reasonable probability of solution by the utilization of the methods which Mr. Barnard has described.

The third head is, of course, by far the most important, and is, I am bold enough to say, epoch-making, and that is the vast question of the structure, if not of the composition, of protoplasm—and when I say of protoplasm I mean, of course, of living protoplasm. Professor Arthur Dendy has summed up one side of this question in an admirable sentence. He says: "It is difficult to form a satisfactory idea of the chemical composition of protoplasm, because it is impossible to analyse it in the living condition; indeed, in the living condition it is constantly undergoing chemical change, and the moment it dies it ceases to be protoplasm."‡ The question of the structure of protoplasm is one before which, to use a common phrase, the brain reels and the senses gape. Our late President, Sir Ray Lankester, recently told me a story which, if it has not been recorded elsewhere, is worthy of record now. Some time in the early part of the latter quarter of the last century, whilst attending a scientific Congress in Belgium he was privileged and astonished to meet Theodor Schwann, the founder of the cell theory,§ who was then a very old man, and indeed had apparently retired from the scientific world for a great many years. Sir Ray Lankester asked him what he had been doing in all those years during which he had never been heard of, and Theodor Schwann told him he had devoted the whole of his time and attention, with the assistance of the most perfected processes and optical apparatus, to an endeavour to establish the existence of any structure in protoplasm—and that his investigations had been absolutely without result. No doubt many Fellows of this Society are familiar with Dr. Bütschli's remarkable work on this subject.‖ I am not going to digress upon the subject of the alveolar nature of protoplasm set forth in that work, but in listening to Mr. Barnard's observations it seems to me that if ever this problem is to be solved, Mr. Barnard has indicated the road which leads to its solution.

Again, Mr. Barnard has hardly more than touched upon the optical methods employed with regard to the cutting off of certain rays of the spectrum and the exclusive use of others. Who shall say that by the utilization of these means we are not upon the threshold of the secret of the chemical constitution of protoplasm itself? To quote Professor

* Verworn, 1888–90. Zeitschr. Wiss. Zool. Leipzig, xlvi. p. 455; l. p. 443. See also Minchin, "Introduction to the Study of the Protozoa," 1912, p. 35.

† See this Journal, 1913, pp. 13–14.

‡ A. Dendy, "Outlines of Evolutionary Biology," 1912, p. 22.

§ "Microscopical Investigations on the Structure and Growth of Plants and Animals" (Berlin 1839) Translation, Sydenham Society, 1847.

‖ O. Bütschli, "Mikroscopische Schäume," 1892. Translated by E. A. Minchin, London, 1894.

Dendy once more :—" The fact that one organism will select silica while another selects carbonate of lime from the same sample of sea-water and for the same purpose, must correspond to some deep-seated difference in the protoplasm of which they are composed, and illustrates very well the diverse potentialities of this remarkable substance." * One may carry this further by a reference to the fact that, again, in the same sample of sea-water, organisms whose protoplasmic bodies are absolutely indistinguishable by the methods hitherto at our disposal have been shown to secrete for the construction of their skeletons the relatively rare substance sulphate of strontium.† As long ago as 1858 Messrs. Claparède and Lachmann published the following remarkable statement : " The animal which secretes the calcareous test of a *Polystomella* cannot be merely a mass of sarcode. The very existence of these complicated tests teaches us that, seeing that we can recognize nothing in the nature of organization in the soft parts of the animal, we must only blame our methods and our means of observation. Where would be the microscopic anatomy of the central nervous system without chromic acid ? The protoplasm of the Rhizopods has not yet found its chromic acid." ‡ I do not think it is too much to suggest that Mr. Barnard is on the high road to the discovery of " the chromic acid of the rhizopodal protoplasm."

One word in conclusion. It may be said that I have laid too great a stress on the branch of this enquiry relating especially to the Foraminifera. It may be said in reply that the naked amœboid forms are more conveniently organized for the purpose of the enquiry, and that such forms as *Proteomyxa* and *Myxotheca* would be easier of manipulation, but I would answer that, rightly or wrongly, Mr. Earland and I have founded upon evidence which we have laid before the Zoological Society, and which will be published in the Proceedings of that Society, the opinion that the protoplasm of the Foraminifera shows by its function and behaviour a higher organization and higher potentialities than that of any other group of the Protozoa. Professor Max Verworn has rightly observed that the unicellular organisms seem to have been created by nature for the physiologists, for, besides their great capacity for resistance, of all living things they have the invaluable advantage of standing nearest to the first and simplest forms of life.§ I see no reason why Mr. Barnard, by the combined use of the methods which he has described and of spectrum analysis, should not one day identify that mysterious unknown constituent—that Aristotelian ἐντελέχεια—for which Sir Ray Lankester has suggested the term " Plasmogen."

I esteem it a great privilege to have been present this evening, and I make bold to say that in years to come there are many of us present to-night who will be proud to be able to say that they listened to Mr. Barnard on this occasion.

Mr. Julius Rheinberg said that, like the Chairman, he ventured to

* A. Dendy, " Outlines of Evolutionary Biology," 1912, p. 26.

† O. Bütschli, 1906, Zool. Anz. Leipzig, xxx., p. 784.

‡ E. Claparède and K. J. F. Lachman, Mem. Inst. Nat. Génévois, 1858, vi., p. 422.

§ G. N. Calkins, " The Protozoa," London, 1901, p. 2.

believe that the lecture they had just heard was not merely interesting, but epoch-making. Mr. Barnard had dealt with two subjects, the one the practical application of skiagraph methods to microscopic objects, the other the possible future development of microscopy on other lines, by the aid of X-rays. The Chairman referred to the great importance of the first method of which they had had such beautiful illustrations, but what in the speaker's mind constituted the epoch-making nature of the lecture, was the idea, for the first time publicly recorded by Mr. Barnard this evening, that X-rays might be made available in the service of microscopy for increasing resolving power now that they were proved to be akin to light waves, but of infinitely shorter wave-length.

For thirty years or more there had seemed to be no possible means of increasing the power of resolution of the Microscope to any marked degree. Mr. Barnard had that evening indicated what the speaker felt sure would be the future lines of progress and development. He had felt that conviction from the moment that it had been suggested to him by Mr. Barnard in a conversation they had had early last year, not long after the publication of Friedrich, Knipping, and Laue's famous paper, in which the properties of X-rays were first shown to resemble those of light rays in ways which had not till then been demonstrated.

At the present time its application to microscopy was still only theory, and it might very well take a long time before substantial progress could be made, and the technique of the methods to be employed worked out, but he thought Mr. Barnard's communication would scarcely fail to have the important effect of stimulating research in this direction.

It was desirable to free one's mind from the idea that the future Microscope, utilizing X-rays, would be anything like the present form of instrument. When it came to dealing with wave-lengths, a thousand or even a few hundred times shorter than those of ordinary light, it was manifestly impossible to use anything in the nature of lenses. That would be like trying to skate on a road paved with cobble-stones. Lenses had to be polished so that any irregularities of their surfaces bore a small proportion to the wave-lengths of the light they were used with; it was hopeless to expect any approach to that with artificially polished lenses, when wave-lengths of the order indicated came into question. It was probable, therefore, that, in the first place, all would have to be done by means of instruments with reflecting surfaces. It was that which had led Mr. Barnard to make experiments with curved mica plates, to see whether it was possible to expand and contract the cones of X-rays, for the power of contracting and expanding cones of light was the primary essential to any optical method of magnification.

Mr. Rheinberg then reverted to Mr. Barnard's improved method of producing skiagrams of microscopic objects, remarking on the ingenuity of the arrangements used. Regarding the possible limits of magnification by this method, he expressed the opinion that this could not be carried beyond comparatively low magnifications, because it was not a case of using any proper optical system, but of producing shadowgraphs by means of a "light" source and diaphragms. The actual sizes of the source of radiation and the diaphragms would play a preponderating role if it were intended to develop magnifying power, and,

unless possibilities were found of making the source and the diaphragms through which the rays passed exceedingly small smaller than was possible in practice—the useful magnification would, in his opinion, always be a very restricted one. He thought, therefore, that no advantage would be gained by pressing that method beyond very moderate magnifications, but the field of interest of the method was, without that, large enough, as all would realize who had been there that evening and had seen Mr. Barnard's remarkable results.

Mr. Maurice Blood asked a few technical questions, particularly whether the anode was connected up with the anti-cathode, and also their respective functions; and, further, whether it might be possible to get magnification by the pinhole camera if there were a very strong source of X-rays? At present, as he understood it, parallel rays were used naturally, giving a "life-size" image, but if it were possible to use a pin-hole this would be an alternative possible method of getting magnification.

Mr. Cheshire said he did not propose to speak at any length, because Mr. Barnard's paper had opened out such a vast range of possibilities, that it would be useless to enter upon them at the present time, but there was one point in connexion with the slides he would like to ask about. As he understood Mr. Barnard, his methods so far necessitated taking the natural size of the object; he supposed that all further magnification had to be done photographically from the negative in the ordinary way. He would also like to know whether, in Mr. Barnard's opinion, so far as he had foreshadowed it, his method could be applied to the photographing of protoplasmic structures in the way the Chairman had indicated?

Dr. Shillington Scales asked what was the equivalent spark-gap of the tube with which the photographs were taken? To which question, Mr. Barnard replied, one inch. Dr. Scales then said he thought Mr. Barnard's lecture had been extraordinarily interesting, though he had been unable to follow his flights so far into the future, and personally he could not see how his hopes were to be realized, though he agreed that in his paper and demonstrations Mr. Barnard had shown that many possibilities were opened up by his method. He had been rather surprised to find Mr. Barnard had any doubt that the granulations in his skiagrams were actually in the Foraminifera. He thought it was hardly possible that they should have been in the plates or screen; they were so manifestly due to the granules in the Foraminifera themselves that he would have thought that no doubt could have arisen.

Dr. G. H. Rodman, Past-President of the Röntgen Society, said that as a visitor he would like to tender his thanks for the opportunity of listening to Mr. Barnard. It had been a particular pleasure to renew his acquaintance with this room, where he had at one time attended so many discussions on the theory and use of the X-rays when it was the home of the Röntgen Society. He had always watched with interest the progress made in connexion with this particular branch of science. He had been induced to come to the Meeting that evening from reading in the 'Morning Post' a notice that Mr. Barnard was speaking on X-rays and microscopy, and as a practical worker in both

these spheres of activity, he felt naturally interested in the subject of the evening lecture. He was well aware of the existence of M. Goby's work on similar lines to those described by Mr. Barnard, and it had been his privilege to criticize it, so that he was well versed in what had been seen in London of the radiography of Foraminifera sent over from Paris. The use of the X-rays in connexion with the Microscope had resolved itself in his experience into two directions. Firstly, the Microscope representation of the effect produced by the cathode rays on the metallic disk known as the anticathode, taken from an old tube which had done its work. If such an anticathode were examined by a Microscope objective, very graphic evidence would be found of the results by the ionic impact which had taken place upon the anticathode. Another and more serious matter, however, such as might arise from the practice of X-ray microscopy, was the appearance of certain diseases, known as X-ray dermatitis, produced by too frequent and incautious exposure to X-rays. A year or so ago the Röntgen Society had a visit from a French surgeon, Dr. Cluny, who produced a very fine collection of photomicrographs in colour of cancerous growths following on the obstinative inflammation of the skin brought about by exposure to X-rays. A hard tube might be used with comparative safety, but this particular soft form of tube required for the work to which Mr. Barnard had been directing their attention was extremely dangerous to use, and he thought he would be wrong if he did not outline the risk run in employing such a tube. One suggestion he would like to make was, that in his work with the X-rays in connexion with the microscopic examination of molluscan shells, he had found it more satisfactory to carry the photography one stage further, and produce negative rather than positive results—and he threw out the hint to Mr. Barnard in this respect. He would like to ask Mr. Barnard on what he based his exposure, whether he judged it by the penetration of the tube, or was it a question of the distance of the object from the anticathode? The weight and density of the specimen examined also entered largely into the calculation.

Dr. Geo. H. Rodman, in speaking of the granularity complained of by Mr. Barnard, said that from experience of many forms of X-ray plates he thought that the lecturer would not suffer in this respect if he used a plate suggested by Dr. Mees and designed by him for special X-ray investigation. In his (the speaker's) hands, and with careful development, this plate left little to be desired. He wished to congratulate the Society upon Mr. Barnard's most excellent paper and demonstration; the results shown upon the screen had been highly satisfactory, and he thought they exceeded in beauty, and certainly in descriptive value, those first of all shown in this country by Monsieur Goby in 1913.

Mr. Barnard expressed his thanks to Mr. Heron-Allen for his extremely laudatory remarks which he felt he really did not deserve. He quite thought with him that at least a light was shed upon what up to then had been impenetrable gloom. He did not think that anything he had said inferred more than that. The particular way in which X-rays could be utilized to their fullest advantage in microscopy

remained for the future developments to decide, but they would be so utilized, and it might not be so very long before something practical would be done.

In reply to questions, Mr. Rheinberg had raised a point as to magnification, and hardly thought that high magnifications would be possible by the method described. He was probably right, but it was perhaps not yet possible to assign any particular limit. The points mentioned in regard to small diaphragms and such like had engaged his attention, and it seemed to him that given a sufficiently small diaphragm a photograph of an average sized diatom might be obtained provided the photographic plate were sufficiently grainless.

In regard to Mr. Blood's questions about the X-ray tube: the water-bulb was a cooling arrangement. The cathode stream acting on the anticathode caused the latter to get very hot. In regard to his question about a pinhole camera, he could not definitely answer this, and he confessed it was rather a new point. But, given a sufficiently small hole in relation to the size of the source of light, it might be possible to do something in this direction.

Mr. Cheshire had asked a question about enlargement; the resulting X-ray photograph was the same size as the object and any enlargement had to be obtained by photographic means. The definition, however, was of a higher order, owing to the fact that the object was in contact with the plate and the X-ray wave-length short. He was in hopes of getting a plate which had no grain whatever, and Mr. Rheinberg had suggested that some organic material such as albumen impregnated with a suitable uranium salt might be used.

In regard to the possibility of photographing organisms or protoplasm, that was a question of the opacity of the substance to X-rays. He believed that so far as the ordinary X-ray tube went, one was very much limited. X-rays as usually generated passed through organic substances without much difficulty, but recent investigations showed that X-rays could be produced at much lower potentials than that used on the ordinary X-ray tube. For the latter a pressure of sixty or seventy thousand volts or so might be used, but lately it had been stated that X-rays could be produced at a pressure of only 500 volts. If this were so, the gap between the Schumann waves and the X-rays might be bridged by a series of radiations which varied from the wave-length of ultra-violet light to that of the average X-ray. Perhaps a radiation having an intermediate wave-length might prove to be extremely valuable. It might even happen that among these radiations a particular wave-length and a possible source of energy would be obtained whereby one might be able to arrive at the structure or the differences of character of organic substances which up to the present had not been possible. Dr. Shillington Scales had mentioned his surprise at the nature of the granulations appearing on the skiagraphs having been questioned, and asserted that in his mind there could be no doubt as to their structural origin. If he had done some of these small photographs, he would not have been surprised. In many cases with exceedingly small objects, the structure was smaller than the grain of the plate; in this case the grain predominated and the structure was not evident. But there were still

points in the photographs which might be ascribed to grain in the plate and not to the structure.

In regard to the point raised by Dr. Rodman as to the danger of using this particular wave length, he would like to say that Dr. Rodman omitted to mention another equally important point, the soft X-rays, while the most dangerous, were the most easily stopped. He had to own that he had not at present any idea how the time of exposure might be systematically arrived at. In such small organisms, one was not, after all, dealing with a gross structure nor very great depths, but merely with a shell; that there were definite limits of exposure he had no doubt, but as to the actual methods by which he had arrived at them he was unable at present to give any definite indication.

The very hearty thanks of the Meeting were accorded to Mr. Barnard for his lecture and demonstration.

The Chairman announced that the suggestions of the Society in regard to the nominations of Officers and Council for the ensuing year had been considered by the Council and would be read out by Mr. Cheshire.

The Chairman said that notice had been given at the last meeting that By-law 36 would be suspended for one year, in order that Professor Sims Woodhead might be elected for a further term of Office.

Mr. E. J. Sheppard proposed and Mr. Rousselet seconded that this By-law should be suspended; and the resolution, having been put to the Meeting, was unanimously carried.

The Chairman called upon the Meeting to appoint an Auditor on behalf of the Fellows.

It was proposed by Mr. J. W. Ogilvy, seconded by Mr. Joseph Wilson, and carried unanimously, that Mr. H. F. Angus be appointed Auditor to act on behalf of the Fellows.

The Chairman announced that the Society had suffered a great loss in the death of Professor Weismann, Honorary Fellow since the year 1879. In connexion with the death of this gentleman, it was an interesting point that Professor Weismann had recently been leader of the movement in Germany that professors should give up their English honorary degrees. The death was also announced of Mr. F. W. Anderton, F.R.C.V.S., who was elected in 1913 and died in October of the present year.

The Chairman called attention to the Roll which was ready for the signatures of those Fellows who had not already signed.

It was announced that the next ordinary meeting of the Society would take place on Wednesday, January 20, when Officers and Council for the ensuing year would be elected.

The Biological Section would meet for its ordinary meeting on January 6. On December 30 it had been arranged that the Section should visit the Laboratory and Museum of the Pharmaceutical Society. It was also announced that the rooms of the Society would be closed from Wednesday evening, December 23, to Monday morning, December 28.

The following Instruments, Apparatus, etc., were exhibited :—

Mr. Joseph E. Barnard. Apparatus demonstrating the application of X-rays to microscopy.

New Fellow :—Lieut.-Colonel John Clibborn, B.A.

MEETING

HELD ON THE 20TH OF JANUARY, 1915, AT 20 HANOVER SQUARE, W.: MR. DAVID J. SCOURFIELD, F.Z.S., VICE-PRESIDENT, IN THE CHAIR.

The Minutes of the Meeting of December 16, 1914, were read and confirmed, and were signed by the Chairman.

An announcement was made of the following Donation received since the last meeting, and the thanks of the Society were accorded to the Donor:—

	From
Gage (S. H.) Optic Projection	*The Author.*

Mr. Thomas H. Hiscott and Mr. E. Smith were appointed by the Chairman Scrutineers of the Ballot for the election of Officers and Council for the ensuing year.

Dr. Shillington Scales announced that the next General Meeting of the Society would be a "Special Meeting" under By-laws 100 and 101, for the purpose of adding a By-law forbidding the use by any Fellow of the letters "F.R.M.S." for any business or professional purposes, a rule which would strengthen the hands of the Council in any difficulty which might arise from the indiscriminate use of these letters.

The Annual Report of the Society for the year 1914 was then read by Dr. Shillington Scales.

REPORT OF THE COUNCIL.

The Council is glad to be able to report the continued prosperity of the Society during the year 1914.

FELLOWS.

Ordinary.—During the year 1914, 19 new Fellows have been elected, whilst 9 have died, 17 have resigned, and one has been removed.

Honorary.—The Council regrets the loss by death of four Honorary Fellows, viz. Dr. Albert Grunow, Dr. L. Dippel of Darmstadt, Ph. Van Tieghem of Paris, and Professor Weismann of Freiburg.

The List of Fellows now contains the names of 405 Ordinary, 1 Corresponding, 30 Honorary, and 81 Ex-officio Fellows, making a total of 517.

FINANCE.

The Revenue Account shows a balance of income over expenditure of £163 3*s.* 4*d.*

Compared with last year the income of the Society shows a slight decrease, but the expenditure has fallen in a greater ratio. This is due to the decrease in the cost of the Journal, and also in the number of papers purchased for the Library—both circumstances being attributable to the war interfering with the supply of foreign periodicals.

During the year, £470 15*s.* 4*d.* has been invested on Capital Account, and £8 2*s.* has been added to Properties Account, by purchase of new furniture.

The value of the Society's securities has been left at the 1913 figure, and this, with the amount added during the year, makes the Investment Account up to £2039 15*s.* 4*d.* The Property Account (excluding Library and Instruments) stands at £88 2*s.*

The sum of £305 17*s.* 4*d.* has been therefore taken from the Reserve Account and added to the Capital Account, making this up to £2127 17*s.* 4*d.*

The Reserve Account, with the balance of £163 3*s.* 4*d.*, mentioned above, now stands at £239 6*s.* 3*d.*

JOURNAL.

The papers, eight in number, which are embodied in the Transactions, have been fully up to the standard of previous years. At the same time, the Council regrets the paucity of contributions, and would impress upon the Fellows the importance of contributing original communications for subsequent publication in the Transactions. Not only are such communications of special interest at the meetings, but it is on their publication to the scientific world that the Society depends for the maintenance of its prestige. The Summary of Current Researches continues to be of the same merit as heretofore, but during the latter half of the year most foreign literature has not been accessible, and the Summaries have consequently decreased in number.

The Council takes this opportunity of again thanking the Editorial Staff, which has laboured long and unremittingly on behalf of the Society and its Journal.

LIBRARY

During the past year the Library has been maintained in an efficient state. Several incomplete journals of little permanent interest have been disposed of, and the proceeds devoted to instituting a much needed fund for the binding of periodicals.

The Council notes the increased usefulness of the Library during 1914, as shown by the number of Fellows visiting the rooms or applying for the loan of books, periodicals, etc., the number of loans being considerably higher than for many years past, while the Society's subscription to Lewis' Circulating Library has fully justified its continuation.

A number of current standard works dealing with Microscopy have been presented during the year, and also the two following valuable early editions:—

St. Vincent (M. B. de) Essai d'une Classification des Animaux microscopiques, 1826. Presented by Mr. John Hopkinson, F.R.M.S.

Nees ab Esenbeck, Horae Physicae Berolinensis, 1820. Presented by Mr. Frank Robotham.

The Society has also recently purchased a number of original drawings of Rotifera by P. H. Gosse. These, together with others already in the possession of the Society, will, as soon as the necessary work of arrangement is completed, be accessible to the Fellows in an album or portfolio.

INSTRUMENTS AND APPARATUS.

The instruments and apparatus continue to be in good condition, and are now suitably housed and displayed. Some progress has also been made in the compilation of a descriptive catalogue.

During the year 1914, in addition to the following donations which have been received, an old French Microscope by Joblot has been added by purchase.

Jan. 21.—Copy in brass of one of Leeuwenhoek's Microscopes. Presented by Sir Frank Crisp, Bart., F.R.M.S.

May 20.—An early copy of John Cuff's "New Constructed Double Microscope" with Latin inscription (about 1744). Presented by Mr. John Sterry.

Nov. 18.—An old portable Microscope, by Cary. Presented by Mr. E. E. Banham.

CABINET.

The Society's Collection of slides has during the year been reviewed, thoroughly overhauled, and cleaned, and the catalogue brought up to date by the Hon. Curator, Mr. E. J. Sheppard, to whom the Society's thanks are due.

The Council regrets to note that but little interest seems to be taken in the Cabinet, and hopes that the Fellows will in the future make more use of the collection of type slides. The following additions have been made during the past year:—

Professor Sigmund's Histological Preparations, 20 slides and descriptive texts. Presented by Messrs. Carl Zeiss, London.

Six old ivory sliders of botanical sections. Presented by Mr. T. G. Taylor.

The number of slides in the Cabinet now amounts to nearly 9000.

MEETINGS.

During 1914, nine Ordinary Meetings have been held, and all have been well attended, but the Annual Conversazione, which is usually held in October, was not held on account of the European War.

The Sectional Meetings have had a very successful year. The Biological Section, under the Secretaryship of Mr. Scourfield, held eight meetings, with an average attendance of 20. The Brass and Glass Section, under the Secretaryship of Mr. Cheshire, held five meetings, with an average attendance of 10.

Mr. Cyril F. Hill (Hon. Treasurer) then read the Financial Statement for the year 1914.

Mr. J. Wilson moved the adoption of the Report of the Council and the Treasurer's Statement.

He wished to congratulate the Society on the excellence of the Report of the Council, which from beginning to end was highly satisfactory.

Regarding the Treasurer's statement, there were two items which he thought required a little explanation for the benefit of the Society. According to the Secretary's statement there were 500 Fellows in the Society, and yet the subscriptions only amounted to £696 odd: he would like to know how it was that the subscriptions fell so far short of the amount which should be brought in by the number of members belonging to the Society.

The second matter he would like to have explained was in regard to the item of £143 put down against "Sundry Creditors" on the debit side of the Balance Sheet, and that of £200 against "Sundry Debtors" on the other side of the Sheet. It seemed to him that both these items were too large to go unexplained in the Balance Sheet of the Society.

Mr. C. E. Heath, in seconding the proposal, asked for information respecting the position of the Society's investments.

Mr. Cyril Hill (Treasurer) replied that, in regard to Mr. Wilson's first

REVENUE ACCOUNT FOR THE YEAR ENDING 31ST DECEMBER, 1914.

Dr.	£ s. d.	Cr.	£ s. d.
To Journal	565 12 0	By Subscriptions	696 8 10
,, Rent and Insurance	160 4 0	,, Admission Fees	37 16 0
,, Salaries and Reporting	126 14 3	,, Sales of Journal	267 6 3
,, Library, Books, Papers and Stationery	114 3 11	,, ,, of Sundry Papers	42 19 0
,, Sundry Expenses, including Postages	32 14 5	,, Interest on Investments	79 8 6
,, Balance	163 3 4	,, Advertisements	38 13 4
	£1162 11 11		£1162 11 11

BALANCE SHEET, 1914.

Dr. LIABILITIES.		£ s. d.
To Capital Funds Account as at Dec. 31, 1913	1822 0 0	
Add transferred from Reserve Account	305 17 4	
		2127 17 4
,, Show Case Fund as at Dec. 31, 1913	20 9 3	
Less expended during 1914	7 3 6	
		12 15 9
,, Sundry Creditors		143 0 1
,, Reserve Account as at Dec. 31, 1913	390 8 3	
Less Subscriptions written off 8 8 0		
Invested on Capital Account 305 17 4		
	314 5 4	
	76 2 11	
Add Balance from Revenue Account	163 3 4	
		239 6 3
		£2522 19 5

Cr. ASSETS.		£ s. d.
By Cash at Bank	144 14 7	
,, ,, on Deposit	50 0 0	
,, ,, in Hand	Nil	
		194 14 7
,, Investments as at Dec. 31, 1913	1569 0 0	
Purchased during 1914—		
£354 Nottingham Corporation 3 %	281 18 1	
£200 War Loan, 1925–28	188 17 3	
		2039 15 4
,, Sundry Properties, Office and Library Furniture	80 0 0	
Added during 1914	8 2 0	
		88 2 0
,, Sundry Debtors		200 7 6
		£2522 19 5

We have examined the foregoing Account, and compared the same with the Vouchers in the possession of the Society. We have verified the Securities as above mentioned, and find the same correct.

A. W. SHEPPARD, H. F. ANGUS, } *Auditors.*

CYRIL F. HILL, *Hon. Treasurer.*

question as to discrepancy between the number of Fellows and the amount of their subscriptions, it must be remembered that a certain number of Fellows were Life Members, the old original Fellows only paid a guinea, and foreign and colonial Fellows paid a guinea and a half.

Referring to the Balance Sheet, the sum "Sundry debtors" was practically the same as last year, subscriptions owing amounted to about £90, and £110 was due for sales of the Journal.

The amount of £143 "Sundry Creditors" was rather more than last year: the principal items were, £21 subscriptions paid in advance, £101 due for printing the Journal, etc. Examining the above figures it would be noted that about £60 more was owing to the Society than was owed by the Society.

With regard to the value of the Investments, these were taken at the same value as last account, that value being based on the official quotations for December 31, 1913.

After this explanation by the Treasurer, the Resolution for the adoption of the Report of Council and the Treasurer's Statement was carried unanimously.

Mr. Bruce Capell said he was glad to have been afforded the opportunity of proposing a hearty vote of thanks to the Honorary Officers of the Society. The great enjoyment given to members at the various meetings of the Society, when so many interesting papers, communications and exhibitions were given, was chiefly owing to the careful and experienced manner in which they were arranged.

Mr. William Gardner said he had very great pleasure in seconding the proposal, which, having been put to the Meeting, was carried unanimously.

Dr. Shillington Scales acknowledged the indebtedness of the Council for the appreciation the Meeting had shown towards their efforts during the year. He would not detain members that evening by any detailed account of the work of the Society—in any case the present year would be an anxious one. The first difficulty at the commencement of the Session which had confronted them was the stopping of the Conversazione which had been such a marked success during the past few years; the Council, however, considered that it was only right to do this in view of the circumstances of the European War. The Secretaries anticipated further difficulties in regard to the carrying on of the Meetings, but he thought all present would agree with him when he said that so far the present Session had brought forward papers and communications of much interest, whilst the Meetings were well attended. The financial position might be considered very satisfactory. There had been a slight drop in Fellowship during the year, though less than had been anticipated in view of the circumstances, and when the war was over it was confidently hoped that the depreciation in numbers would again be made up.

Mr. Edward J. Sheppard proposed that the best thanks of the Society be accorded to the Auditors and to the Scrutineers of the Ballot.

Mr. Freshwater seconded the proposal, which was put to the Meeting and carried unanimously.

The Scrutineers having handed in their report of the result of the Ballot, the Chairman announced that the following Fellows had been elected as the Officers and Council for the ensuing year:—

President—Prof. G. Sims Woodhead, M.A. M.D. LL.D. F.R.S.E., etc.

Vice-Presidents—John Hopkinson, F.L.S. F.G.S. F.Z.S.; Julius Rheinberg; David J. Scourfield, F.Z.S.; E. J. Spitta, L.R.C.P. (Lond.) M.R.C.S. (Eng.).

Treasurer—Cyril F. Hill.

Secretaries—J. W. H. Eyre, M.D. F.R.S.E.; F. Shillington Scales, M.A. M.D. B.C. (Cantab.).

Ordinary Members of Council—F. W. Watson Baker; Frederic J. Cheshire; C. Lees Curties; Arthur Earland; R. G. Hebb, M.A. M.D. F.R.C.P.; Prof. R. T. Hewlett, M.D. F.R.C.P. D.P.H., etc.; J. Milton Offord; Robert Paulson; Percy E. Radley; Charles F. Rousselet; A. W. Sheppard; Charles D. Soar.

Librarian—Percy E. Radley.

Curator of Instruments, etc.—Charles F. Rousselet.

Curator of Slides—Edward J. Sheppard.

Dr. Charles Singer, M.A., then communicated his "Notes on the History of the Microscope," on the conclusion of which the Chairman pointed out that the evening's paper on the earliest microscopical investigations of the past formed a most interesting and valuable counterpart to that to which they had listened with so much interest and attention last month, when they had been bidden to look forward to the Microscope of the future, and he thought the contrast might form the basis of an interesting discussion. The subject had not, he thought, been brought before them in quite the same light before. As a rule papers dealing with the beginnings of microscopy had been on the construction and use of the Microscopes and lenses themselves, but he was sure that all would agree that the very early work carried out by the pioneers of microscopical investigation by means of the instruments at their command, formed a most interesting side of the question.

Dr. Shillington Scales said he would like to add his thanks to those of the Chairman to Dr. Singer for his great kindness in giving his very interesting lecture that evening. He would like to ask Dr. Singer whether he had seen a paper published in the Journal of the Society which had been read a few sessions ago by their late President, Dr. Plimmer, on Leeuwenhoek, dealing with his work and accompanied by several very interesting illustrations? He had been struck by the great interest of the illustrations handed round by Dr. Singer and thought they would be well worth reproducing in the Journal.

The Society had both a biological and a microscopical point of view, and he believed that there were few advances in the improvement of the Microscope with which the Society had not been directly associated. It had a unique collection of old instruments and prided itself upon bringing this collection to perfection. He wondered whether Dr. Singer was familiar with this collection. They were at that present moment

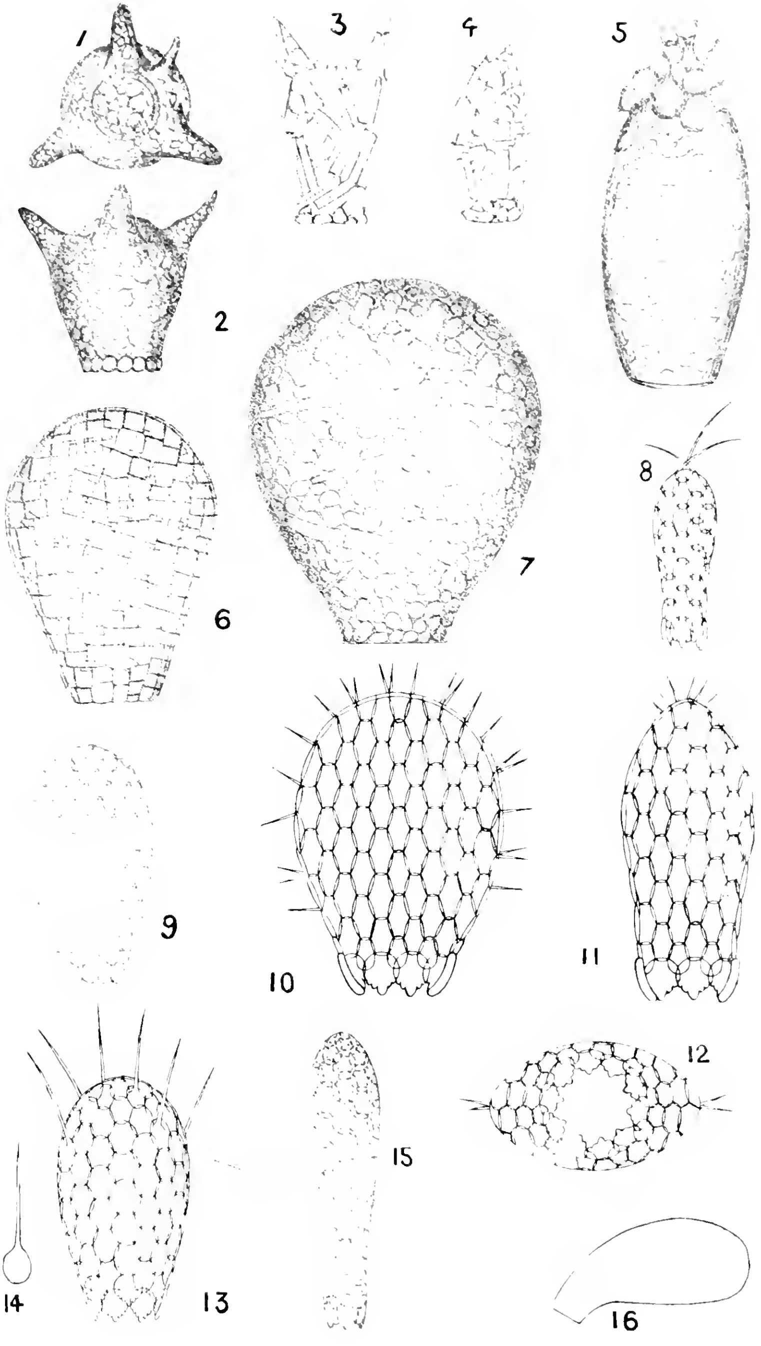
engaged (under the guidance of Mr. Cheshire and of those who worked with him) in preparing an illustrated catalogue of the instruments in their possession, and he was certain that Mr. Cheshire and his colleagues would only too gladly welcome any collaboration which Dr. Singer might offer them.

The vote of thanks to Dr. Singer for his paper was carried with acclamation by all present.

The Chairman announced that the Roll was there ready to be signed by Fellows who had not already done so.

It was announced that the next Ordinary Meeting would take place on Wednesday, February 17.

It was further announced that the next Meeting of the Biological Section would be held in the Society's Rooms on February 3.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JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

APRIL, 1915.

TRANASCTIONS OF THE SOCIETY.

II.—*Notes on the Structure of Tests of Fresh-water Rhizopoda.*

By George Herbert Wailes, F.L.S.*

(*Read March* 17, 1915.)

Plates II and III.

The Rhizopoda are amœboid animals, and may be classed as parasitic, fresh-water, or marine, according to their habitat; a few of the fresh-water species can live in salt or brackish water. Under the term "fresh-water" are included terrestial species which inhabit mosses of all kinds and are capable of enduring more or less prolonged dessication. They are to be found nearly every-

* Communicated by John Hopkinson, V.P.R.M.S.

EXPLANATION OF PLATE II.

Fig. 1, 2.—*Difflugia bicornis* Penard. Three-horned variety. × 300. 1. Buccal view. 2. Side view. Showing a fourth horn placed unsymmetrically between two of the three normal horns.
,, 3, 4.—*D. bacillariarum* var. *elegans* (Penard) Cash. × 300. 3. Broad view. 4. Narrow view.
,, 5.—*Heleopera nodosa* Wailes. × 250.
,, 6.—*Nebela scutellata* Wailes. × 320.
,, 7.—*N. dentistoma* var. *hesperia* Wailes. Broad view of test, showing various scales, plates, etc., incorporated in it. × 300.
,, 8.—*Euglypha cristata* Leidy. × 400.
,, 9.—*E. scutigera* Penard. × 300.
,, 10–12.—*E. strigosa* (Ehrenb.) Leidy. × 350. 10. Broad view. 11. Narrow view. 12. Buccal view.
,, 13, 14.—*E. armata* Wailes. 13. Side view of test. × 300. 14. Detached spine-bearing scale. × 400.
,, 15.—*E. brachiata* var. *librata* Wailes. × 400.
,, 16.—*Cyphoderia ampulla* Ehrenb. Outline of test. × 200. (The test of *C. trochus* var. *amphoralis* Wailes is of a similar form.)

where; the sediment and water-plants of every little stream or pond will yield them more or less plentifully, *Sphagnum* moss always provides multitudes of them with a habitat, and the mosses growing on walls, trees, and even on the pavements of towns provide shelter for their appropriate species.

These unicellular animals have provided valuable subjects of study to biologists, and their life-histories and habits, of which little is now known, are sure to provide a mine of information to naturalists in the future; how such creatures, without any differentiated organs, can build their habitations with such symmetry and marvellous accuracy of workmanship is a question which cannot fail to strike the most cursory observer.

The sub-class Rhizopoda comprises the orders Amœbina, or naked forms, and Conchulina, or those furnished with a test; the families Arcellida and Euglyphina include the genera whose tests yield the most interesting results from a microscopical examination. The size of the tests usually lies between 15μ and 150μ in length, although specimens up to 500μ do occur. For locating a specimen in a drop of "material" a $\frac{1}{2}$-in. objective, with a large field, is most convenient; for the detailed examination a $\frac{1}{6}$-in. objective is best as a rule, but may often be usefully supplemented by a $\frac{1}{8}$-in.; for the detailed examination of such tests as those of the *Cyphoderiæ* and of individual scales, etc., a $\frac{1}{12}$-in. oil-immersion lens is required.

For the *modus operandi* of collecting and mounting the tests Penard's paper, "On the Collection and Preservation of Fresh-water Rhizopoda,"* should be consulted. If drawings are made, a camera-lucida should be used to ensure accuracy, and the dimensions should be checked by measurements of the object itself; micro-photography unfortunately does not as a rule give good results unless the tests are flat or parts of them specially prepared.

For the identification of species Cash and Hopkinson (*2*) † or Penard (*4*) should be consulted; the latter work embodies nearly all the information available on the subject.

The Rhizopoda are propagated by three methods:

1. By means of spores which grow into amœboid individuals and then construct tests.
2. By "budding."
3. By simple division into two individuals.

Very little is known of the process by which the tests are made in the first two cases, but the naked animal must of necessity either secrete its test or search for the materials with which to construct it. In the third case the process can frequently be seen in some of its stages, but probably has never been observed in its entirety,

* Journ. Quekett Micr. Club, 1907.

† The figures in brackets refer to the Bibliography at the end of the paper.

which may perhaps extend over a period of some days. Previous to division in many species an accumulation can be observed of the necessary scales or disks, etc., required for the construction of the daughter test, these being stored without any apparent order in the body of the parent; when grains of sand or other extraneous materials are employed they are occasionally to be seen collected around the aperture of the parent's test.

The new test is commenced by building its aperture adjoining that of the old test, and so course by course in rings until it is completed. In cases where scales are employed, e.g. in the genus *Euglypha*, the special aperture-scales are affixed first, and then the body-scales and spine-scales or spines, until on its completion we see two similar tests joined together by their apertures; the animal then divides, a moiety occupying each test, and on their separating two mature and similar animals are the result. Care must be taken not to mistake two animals conjugating for the above, as the position of the two tests is similar.

Rhizopoda tests can be grouped according to their structure in four categories, viz., those composed of:

1. A skin or shell more or less homogeneous.
2. Extraneous materials collected by the animal.
3. Extraneous materials modified by the animal.
4. Materials, usually scales or disks of various forms, secreted by the animal itself.

In the first group the tests may vary from a thin flexible pellicle, which is a mere hardening of the ectoplasm, to a firm and comparatively thick shell, such as those of the *Arcellæ*.

Although hardly within this catagory, the case of *Amœba pilosa* Cash (*2*) is well worth examination; unfortunately this curious species seems to be of rare occurrence. The plasma flows in the usual amœboid manner, but is covered with fine colourless hair-like cils which appear on the lobular expansions as they are formed, and are absorbed again when they are withdrawn.

Cochliopodium bilimbosum (Auerbach) Leidy and other species of that genus have flexible pellicles, colourless and transparent, but in edge view, that is, in section, appear to be divided by transverse striæ at equal distances apart, whilst in face view a careful examination reveals numerous punctuations, or rather minute beads arranged in a series of lines radiating from the crown of the test. Penard (*4*) thinks these markings may represent little pellets or disks of a firmer substance than the rest of the test; they are not distinguishable in very young individuals. Careful treatment of tests with a solvent of various degrees of strength might elucidate the question.

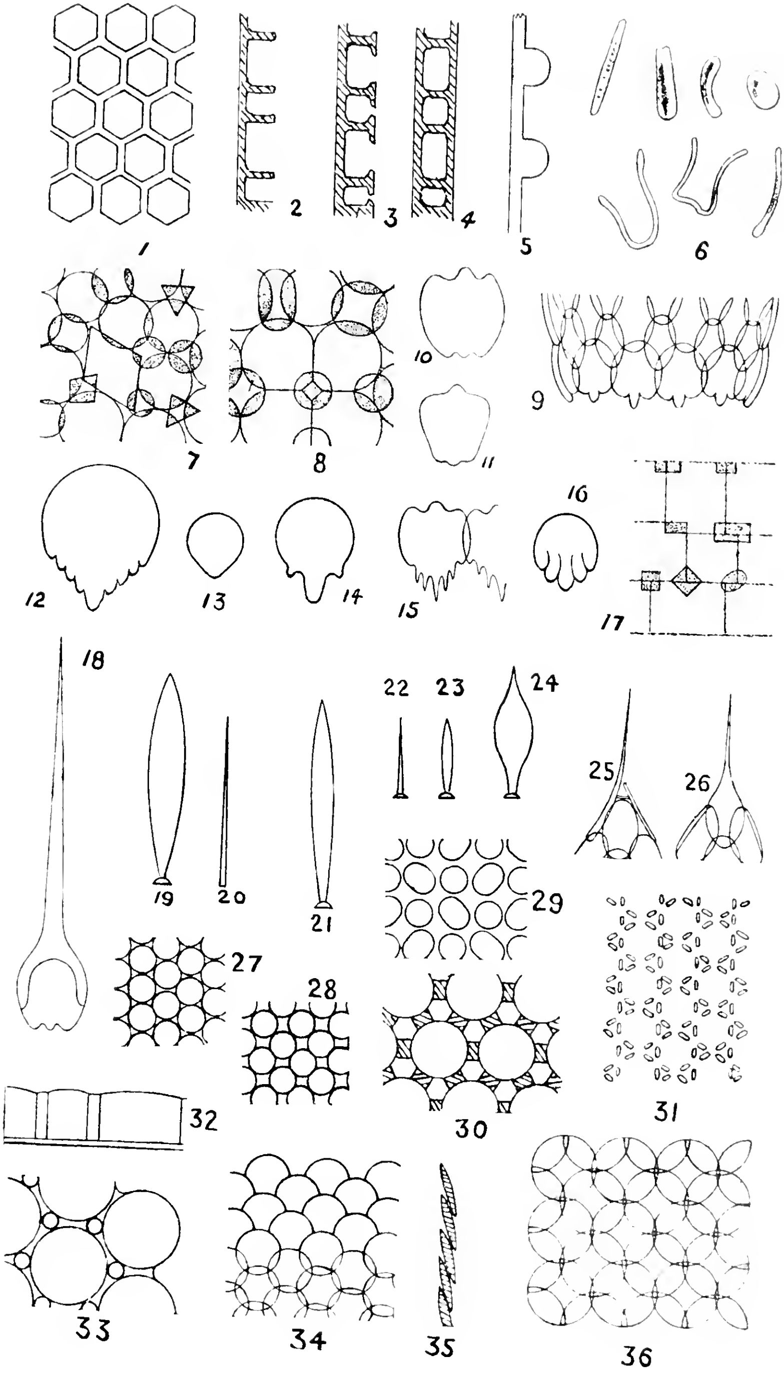
Species of the genus *Corycia* have remarkably thin flexible envelopes, the free edges of which, around the aperture, resemble

diaphanous elastic curtains in some cases; although of such a diaphanous nature the crown of the test of *C. flava* (Greeff) Penard is studded with small particles of extraneous materials affixed to its outer surface, and in the case of *C. flava* var. *coronata* (Penard) Wailes, has a projecting ring or circular fold of membrane around the crown of the test; whilst *C. aculeata* (Greeff) Averintzeff has a circlet of stout spines.

The tests of most species of *Arcella* appear punctate under a low power, but a higher magnification gives them the appearance of being formed of circular or hexagonal disks cemented together (Pl. III, fig. 1). Penard (*4*), with his usual accuracy, shows that the test of *A. vulgaris* Ehrenb. consists of a thin chitinous plate covered on one side with a network of low ribs forming shallow hexagonal cells, the free edges of these ribs becoming thickened, this thickening increasing with the age of the animal, until from a girder-like section they eventually coalesce at their free edges, and the fully mature test finally consists of two plates joined together by a network of ribs, and it is owing to the spaces between them as seen through the translucent plates or coverings that the tests have a punctate appearance. As the tests are only

EXPLANATION OF PLATE III.

Fig. 1.—Surface of portion of an *Arcella* test. × about 2500.
,, 2–4.—Section of the same. 2. When immature. 3. When older. 4. Mature test. × about 2500.
,, 5.—Section of test of *Arcella artocrea* Leidy, through "pores" around the aperture. × 2000.
,, 6.—Silicious elements of test of *Nebela griseola* Penard. × about 800.
,, 7, 8.—Portions of test of *N. vitræa* Penard. × 1000. (After Penard.)
,, 9.—Side view of aperture of *Euglypha ciliata* Ehrenb. × 1000.
,, 10.—Body-scale of *E. crenulata* Wailes. × 1000.
,, 11.—Ditto of *E. crenulata* var. *minor* Wailes. × 1000.
,, 12.—Aperture-scales of *E. alveolata* Dujardin. × 1000.
,, 13. Ditto of *E. lævis* Perty. × 1000.
,, 14. Ditto of *E. rotunda* Wailes. × 3000.
,, 15. Ditto of *E. crenulata* Wailes. × 1000.
,, 16. Ditto of *E. compressa* Carter. × 1000.
,, 17.—Portion of test of *Nebela scutellata* Wailes, showing the small strengthening plates over the joints of the larger plates. × 1000.
,, 18.—Spine-scale of *Euglypha crenulata* Wailes. × 800.
,, 19–24.—Spines of various forms of *E. compressa* Carter. × 1000. 23. Normal form. 20, 22. Narrow edge views.
,, 25, 26.—Apex of test of *E. mucronata* Leidy. × 1000. 25. Narrow view. 26. Broad view.
,, 27–29.—Portions of tests of *Cyphoderia ampulla* Ehrenb. × 2000.
,, 30.—Portion of a test of the same. × 4000.
,, 31. Ditto ditto of *C. ampulla* var. *major* Penard; a rare form from Yorkshire. × 2000.
,, 32, 33.—Portion of a normal test of the same variety, showing test in section (32), and a portion of the surface with a line of fracture (33). × 4000.
,, 34–36.—Portions of two tests of *C. trochus* var. *amphoralis* Wailes, and section (35). × 2000.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about 1 μ to 2 μ in total thickness, a magnification of $\times$ 1500 or more is necessary for their examination, which presents a good many technical difficulties. Cushman and Henderson* give microphotographs of *Arcella* tests, together with a description of their methods of procedure; there is, however, room for further investigation. The test of *A. mitrata* Leidy offers perhaps the least difficulty in examination owing to its exceptional thickness and large cells; the species is, however, rare in Britain, although plentiful in the United States. (See Pl. III, figs. 2–4.)

Centropyxis aculeata (Ehrenb.) Stein has a stout chitinous test more or less overlaid with particles of extraneous material. Under a moderate magnification the envelope, where visible, appears punctate, but these markings are not really perforations but small plates or disks embedded in the chitin; by treating the test with a solvent, such as caustic potash of carefully regulated strength, they might possibly be isolated and their exact nature ascertained. These tests are furnished with a varying number of hollow chitinous spines, the small extremities of which are frequently plugged by minute splinters or pointed grains of silica, a peculiarity which is even more pronounced in the case of the spines of *Difflugia echinulata* Penard (*6*), the only known species of that genus bearing spines on its test.

Many tests possess what appear to be pores, e.g. around the apertures of several species of *Arcellæ* and on the necks of some *Nebelæ*, but if the test be broken and examined in section it will often be found that these "pores" are in reality minute hemispherical nodules on either the outer or inner surface (Pl. III, fig. 5); true pores can be recognized as a rule in broken sections, or may be revealed by minute bubbles of gas escaping through them when the tests are treated with acid or otherwise manipulated. Transference from water to oil of cloves sometimes reveals them.

Group 2 contains a large proportion of the fresh-water species of Rhizopoda; the tests are similar in principle to those of the familiar caddis-worm, being constructed of particles of sand or other material cemented on to a pellicle, and the form of the finished structure is characteristic in each species.

A drop of sediment from any pond or stream, or a squeezing from a moist piece of moss, is nearly sure to provide examples of one or more species of *Difflugia*, which may be taken as typical of this group; they are easily kept alive for observation if supplied with fresh water now and then, and with patience an observer may have the opportunity of seeing the process of construction of a new test; in any case, if powdered glass of various colours be provided, any new tests will be seen to have these coloured grains incorporated in them.

* Amer. Nat., xl. (1906).

Difflugia oblonga Ehrenb. may be taken as a type of the tests in this group; it is more or less pear-shaped with a circular aperture at the smaller end, the outlines are as regular as the selection of fairly evenly-sized sand-grains will permit, the inner surface is smooth and the interior is nearly entirely occupied by the animal.

The tests of many species of *Difflugia* have pockets forming horn-like extensions; these may vary in number from a single terminal one to a dozen, as in *D. corona* Wallich, and these horns are occasionally terminated by a sharp splinter or grain of sand. They are, when normal in number, placed symmetrically on the test, but additional ones are apt to be inserted unevenly, as in *D. bicornis* Penard (Pl. II, figs. 1, 2).

A very common material used to form tests consists of diatom frustules; a few species such as *D. bacillifera* Penard and *D. bacillariarum* Perty (Pl. II, figs. 3, 4), employ them almost exclusively; many others intermix them with other materials.

The tests in this group have usually circular apertures, occasionally they are elliptical, and several species have lobed or crenulated openings with a marked tendency to variation in the number of lobes. Thus, in *Difflugia gramen* Penard and *D. lobostoma* Leidy, three or four is the normal number, but five or six are not rare; *D. oviformis* Cash has three to five, and *D. corona* Wallich twelve to twenty. In connexion with this kind of aperture it is curious that in Europe the *Arcellæ* rarely depart from the circular form of aperture, whilst in North America the crenulated form frequently occurs in several species.

The genus *Pontigulasia* presents us with a different type of aperture; the test proper is more or less oviform and similar in material and appearance to that of a *Difflugia*, but over the small end, which has one or more openings, is fixed a short conical tube contracted at the line of junction, the outer end forming the visible aperture. The orifice or orifices of the test proper are therefore provided with a small vestibule or anti-chamber. *Pontigulasia bryophila* Penard has a single circular inner orifice; *P. spiralis* Rhumbler has two such; *P. incisa* Rhumbler and *P. compressa* (Carter) Cash have two also, but formed by a narrow bridge-piece placed across a circular opening; *P. vas* (Leidy) Schouteden has a single inner orifice placed eccentrically, and usually a second one opposite which is closed or covered over by a translucent diaphragm. The junction of the buccal tube with the body of the test is very frequently strengthened by some large quartz-grains, cemented around it at equal distances apart.

The tests of the genus *Lesquereusia* are similar except that their form is spheroidal and the outer tube is affixed tangentially; in some instances it is so short as to merge into the general outlines of the test, and in *L. mimetica* Penard (*6*) does so completely.

The examination of these structures entails careful manipulations, being opaque in air or water; immersion in oil of cloves or balsam, which renders them translucent, is necessary before the internal structure is distinguishable, and then close scrutiny from every point of view and careful lighting are requisite.

The curved vermiform rods forming the test of *Lesquereusia spiralis* Bütschli, and similar ones often incorporated in the test of *Nebela griseola* Penard (*8*), may be formed from diatom frustules, but they are so reduced in diameter and bent into all manner of curves that we can only conjecture their origin in many cases (Pl. III, fig. 6).

The tests in Group 3 comprise those which are formed, either wholly or in part, of extraneous materials modified by the animal; these materials are usually silicious, such as sand-grains, frustules of diatoms, and sometimes the scales or plates of other tests, although these are usually employed without modification. The walls of the test when completed resemble a mosaic, the tesseræ fitting closely together and adjusted so that no large intervals are left; even between those of most varied forms they are cemented together with a chitinous cement. The walls are of equal thickness or made thicker in those parts where extra strength is required, and are finished off to a smooth surface both inside and out.

Of the tests made partially as above, some species of *Heleopera* provide good examples; *H. petricola* Leidy, a common species, has a test made of sand-grains which are smoothed off around the aperture and anterior part of the test, but near the crown larger grains usually project and the surface is rough; the test of *H. nodosa* Wailes (*9*) shows this tendency carried to an extreme, the apex consisting of a nodular mass of grains of quartz (Pl. II, fig 5) which must, one would think, greatly impede free locomotion. The cementing medium is highly resistant to the action of acids, and probably consists of chitin mixed with very fine particles of silica. There is also a general tendency among most species of this genus for the tests to assume an amethystine tint which is very brilliant in such species as *H. rosea* Penard and *H. petricola* var. *amethystea* Penard; the shades vary from pale violet to a rose-red, but the colours usually seen are similar to those produced by oxide of manganese; the colouring matter is probably confined to the cementing material with which the quartz-grains are perhaps coated. In the case of *Awerinzewia cyclostoma* (Pen.) Schouteden, this is evidently the case, as the test is usually composed of rather large grains of a chalky white tint embedded in a violet-coloured matrix.

The genus *Nebela* contains many abundant and widely distributed species with tests composed of modified extraneous materials, and of plates or disks which appear to be secreted by the animal itself, or obtained from some other test; sometimes it is possible to recognize the exact species from which some of the

materials are derived; the spine- and aperture-scales of *Euglypha alveolata* and *E. armata* are not infrequent, and tests of *Nebela equicalceus* Leidy have been observed containing the body-scales of *Euglypha crenulata* var. *minor* (*9*). The oblong and rod-shaped plates so often seen in these tests usually afford no indication of their origin, but occasionally close inspection will reveal traces of the striæ characteristic of diatom frustules, and it is not unlikely that diatoms are a source from which the necessary material is largely obtained. A few species, e.g. *Nebela scutellata* Wailes and *N. tropica* Wailes (*9*), employ square plates in forming their tests, sometimes with the addition of about 5 p.c. to 10 p.c. of circular disks, all of which are probably secreted by the animal itself, unless they have been obtained from old tests of the same species. A curious feature in the test of *N. scutellata* is that many of the points of junction of the plates are reinforced by the application over them of small covering plates of suitable size and shape, usually rectangular, sometimes circular, oval, or triangular (Pl. III, fig. 17). The larger plates are arranged in more or less orderly diagonal series. The test of *N. vitraea* Penard has also occasionally a similar arrangement of small covering plates (Pl. III, figs. 7, 8).

Nebela barbata Leidy, recorded two or three times only from the British Isles, but not uncommon in North America, is remarkable for the fact that its test is thickly covered with fine, colourless, hair-like cils 10–18 μ in length, and less than 0·5 μ in diameter; they are insoluble in cold sulphuric acid, and become invisible in oil of cloves, glycerin, and balsam.

The tests in Group 4 belong mostly to the family Euglyphina, and usually consist of transparent, silicious scales or plates elliptical in form, arranged more or less symmetrically, the edges overlapping and cemented together. The genus *Quadrula* has rectangular plates forming the tests, and the genus *Cyphoderia* is characterized by the use of small disks. In all these cases the materials for the test have to be secreted by the animal itself, and it is of frequent occurrence to find individuals whose bodies enclose numbers of scales, etc., ready to be used in the formation of a new test. The genus *Euglypha* provides some of the most interesting and easily procurable examples of this group, a "squeezing" from any tuft of damp moss being nearly sure to provide numerous specimens, of which *E. ciliata* Ehrenb. may serve as the type. Its test is oviform or pyriform, compressed, with an elliptical aperture, it is from 40 μ to 90 μ in length, and is usually furnished with numerous short spines around its edge as seen in broad view; the aperture is bordered by about eight to ten scales, which have a projecting point or tooth on the centre of their free edges (Pl. III, fig. 9); all the other scales of the test are elliptical, and arranged regularly in alternating longitudinal rows; the spines are circular

in section, tapering to a sharp point, and affixed to the scales where they overlap. As the scales are arranged in longitudinal rows, it follows that there is always an equal number of scales in any transverse section of the test, and, therefore, the scales in the broadest part of the test are the widest, and those at the crown the narrowest; they are all of the same length. If there are eight aperture-scales there will be sixteen rows of scales, with, say, ten scales in each row, making some 160 in all, a few being usually omitted at the apex, and all, or nearly all, of these are formed by the parent preparatory to building the test, and are stored with no apparent order within its plasma. The question naturally arises how it is able to sort out and affix each of these in its appropriate position; even if the body-scales are made narrow and widened to suit the position in each case, the aperture-scales must be selected, for they are often distinguishable among those stored up ready for use, together with the spines which are subsequently placed in position on the outside of the test. The process of building such a test has never been observed in its entirety, but it is to be hoped that the good fortune of some observer endowed with the necessary time and patience will soon enable it to be fully described.

As a rule the body-scales of *Euglypha* tests are all very similar, being elliptical or circular in form, but four species have scales which are quite characteristic in each case; the test of *E. scutigera* Penard (*8*) has heart-shaped, or rather shield-shaped scales (Pl. II. fig. 9); those of *E. crenulata* Wailes (*9*) are similar, but the base or point of the shield is truncate and waved with three projections (Pl. III, fig. 10), and those of its var. *minor* Wailes (*9*) are slightly different in form with only one projection at the base (Pl. III. fig. 11), whilst the scales of *E. aspera* Penard have projecting thorn-like points on the upper part of each.

On the other hand, the scales which border the apertures of the tests are characteristic in every species, the variations consisting in the number and shape of the teeth or points indenting their free edges, also in their differences of size, thickness, and curvature, thus rendering it possible to assign even an isolated aperture-scale to the species to which it belongs. In examining these scales on a test, care must be taken that their true shape is seen, which owing to their curvature cannot be done when the test is lying in a normal position, but the aperture has to be raised up until the points of the scales lie in the plane of vision; in the case of small tests a considerable magnification and careful lighting are needed.

The spines with which many species of *Euglypha* arm their tests show considerable variety, both in shape and method of attachment. They fall into two groups: (1) those which are

attached to the outside of the test; and (2) those formed by a modification and extension of the body-scales.

In the first group, containing four species, the spines of *E. ciliata* and *E. strigosa* (Ehrenb.) Leidy (Pl. II, figs. 10–12), are circular in section and taper to a point, with bases cemented to the test; the spines of *E. filifera* Penard are similar, but longer, few in number and spaced at equal distances apart on a plane passing through the longitudinal axis of the test; at the base of each is a small hemispherical nodule into which the spine is fixed, its base being somewhat enlarged, thus forming a kind of ball-and-socket joint, enabling the spine to be bent considerably in any direction without breaking away from the test; the spines of the tests of *E. compressa* Carter (Pl. III, figs. 19–24), and of *Placocysta spinosa* Leidy are attached in a similar manner. It should, however, be noted that it requires a magnification of 1000 or more and favourable conditions to reveal this structure, and possibly the movement of the spines may in many cases be due to their being forcibly bent at their base. In the case of the two last-mentioned species the spines are flattened and usually lanceolate, but show considerable variation of form in different individuals.

In the second group certain scales are prolonged into spines of variable length; they are usually either around the upper part of the test or form a tuft or crest at its apex, as in *E. cristata* (Pl. II, fig. 8). *Euglypha brachiata* Leidy has a test noticeable for the long spines originating near the aperture, which are circular in section, tapering gradually to a point; they are usually two or four in number, but occasionally so many as six or eight are present. In the test of its var. *librata* Wailes (*9*) they originate about half way up the test and are flattened at the points, which resemble oar-blades (Pl. II, fig. 15); their total length is about 35 μ with a diameter of about 1 μ, widening to 2·5 μ at the free extremity.

Euglypha mucronata Leidy has usually a single spine placed at the apex of the test, the terminal scales fitting closely together around its base (Pl. III, figs. 25, 26), but if any interstice remains a small transverse diaphragm is formed just below it; the spine lies normally in line with the axis of the test, and to ensure this is bent the requisite amount close to the scale which bears it.

In the genus *Cyphoderia* a distinct type of test is found, flask-shaped, with a curved neck; under a moderate magnification it appears densely punctate, but under higher powers its composite structure is plainly visible. Two distinct types of structure occur, one formed of small flat disks cemented together at their edges, and the other of imbricated circular scales; these disks or scales are often to be seen within the tests of individuals collected in readiness for the building of a new test. *C. ampulla* Ehrenb.

(Pl. II, fig. 16) may be taken as typical of the first group. The small disks of which the test is formed are from $1 \cdot 5\ \mu$ to $2 \cdot 5\ \mu$ in diameter and $1 \cdot 5\ \mu$ to $2\ \mu$ in thickness. They are affixed to a very fine pellicle which lines the interior of the test, and are arranged in several different ways (Pl. III, figs. 27–29); they may lie closely together in alternating or in parallel rows, or they may be separated from each other by a distance equal to about one-third of their diameter, in which case bands of darker-coloured cementing material may usually be discerned joining each disk to its neighbours (Pl. III, fig. 30). In the majority of tests all the disks are circular, but they may also be all oval, or circular and oval disks may be mixed.

Whether these differences in the structure of the tests are inherited or merely individual variations is not known, but more than two different variations of the test are seldom found in the same gathering, and very often the tests from one locality are all similar.

C. ampulla var. *major* Penard (*4*) is distinguished from the type by the presence of six (sometimes twelve) small pores around each disk of the test (Pl. III, fig. 33). These pores are about $0 \cdot 5\ \mu$ in diameter and usually circular; they are filled by a chitinous material more soluble in acid than the rest of the test.

Cyphoderia trochus Penard (*4*) and its varieties (*8*) are characterized by their tests being formed of small circular disks which are convex on both sides and overlap each other; they are arranged in parallel rows; the amount of imbrication varies in different individuals, and even in different parts of the same test, being greatest where the diameter of the test is least. The disks are $4\ \mu$ to $5\ \mu$ in diameter, and distinguishable under a moderate magnification. These tests are easily examined if a portion be broken off and mounted in a fairly liquid balsam, so that it can be flattened out by pressure on the cover-glass; an oil-immersion objective can then be used with advantage.

The various tests to which attention has been drawn in these notes represent only a few of the species of fresh-water Rhizopoda, many of which can be collected during a country walk or holiday excursion. The beauty of the designs and the perfection of workmanship expended on these little homes, together with their permanence when mounted, should render them favourite objects with microscopists, whilst for those who possess the requisite time and patience to keep the living animals under observation there is the incentive that at present their habits and modes of life offer an almost unworked field of study, and the naturalist interested in the problems of instinct, reason, and heredity is sure to gain, from the study of these minute and primitive members of the animal kingdom, information tending towards their solution.

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III.—*A New Mitotic Structure disclosed as the Result of New Technique.*

By E. Sheppard, F.R.M.S.

(*Read March* 17, 1915.)

Plate IV. and Fig. 15.

For some time past I have been experimenting with different stains and staining processes, in order, if possible, to obtain further knowledge relating to various mitotic structure, little anticipating at the commencement of my work that my efforts, and the comparatively few trials which I made, would so soon be rewarded. From the outset my object was to increase the staining power of the spindle-fibres and other archoplasmic structure that might be present in the vegetable cell.

I was of opinion that if this could be achieved, and any improvements upon the results obtained from present-day technique achieved, the best line on which to proceed was to use mordants suitable to the different stains with which I was about to experiment.

It is not necessary for the purpose of this paper to describe the various single and combination staining baths with which I experimented, but I may mention that the majority gave poor results, and others no better, if as good, as those obtained with standard formulæ.

My best results have been obtained with the mordanted aniline dyes used in conjunction with Heidenhain's iron-hæmatoxylin method.

With this combination carefully and successfully applied, a single trial will fully convince the worker what wonderful contrast and magnificent crisp definition may be obtained. There are doubtless many other aniline dyes which may be similarly worked in conjunction with Heidenhain's iron-hæmatoxylin process, and possibly may give even more gratifying results than those which I have already obtained, and open up a wide range of work; to this I hope to return when time permits.

For the present, though, I have been experimenting for but a short time with this special branch of cytological technique, and have confined my investigation entirely to the bringing out of mitotic structure in the vegetable cell; the results have been so pleasing and startling that I have felt compelled to write a short

account of my results and to draw special attention to a structure, not hitherto described, which it has helped me to disclose.

In working with this process I have used several well-tried aniline dyes, which in most cases have given satisfactory results, but so far none have given such striking and gratifying results as those obtained by the use of methyl-blue in combination with Heidenhain's iron-hæmatoxylin.

As yet, the method has been tried upon not very thin sections of vegetable tissue only, and upon one subject (*Lil. auratum*). I have repeated the process several times, but each time with equally successful results, the new structure being so pronounced that I feel sure if I had had other similar material of different species at my command to be treated in a like manner, the same structure would be brought into view.

The following is a short description of my methods :—

Paraffin sections (15μ to 20μ) of the above-mentioned material, fixed in Flemming's strong solution, are made to adhere to the slide or cover-glass (preferably the latter), either by the water, or one of the modifications of Meyer's albumin process. I use six drops of Meyer's albumin to one ounce of tap-water

After the removal of the paraffin, the sections are brought down to water in the usual manner, and finally washed in distilled water. The sections on the cover-glass are now mordanted for about fifteen minutes in a 1 per cent watery solution of permanganate of potash, and then lightly rinsed in distilled water and placed in a strong watery solution of methyl-blue, where they are allowed to remain at least over-night—twelve hours or a little more will do no harm. They should then be well washed for a few moments in one or two changes of distilled water, mordanted in a 3 per cent solution of iron alum and stained by Heidenhain's hæmatoxylin. I give not less than six hours in the iron alum and from twelve to twenty-four hours in a 0·5 per cent watery solution of hæmatoxylin.

The delicate part of the work now commences, that of differentiation; and it is not at all easy to lay down any fixed rules or times to ensure the success of this, the most important part of the technique.

Carried too far, or insufficiently done, the particular section or series on the cover-glass is spoilt and may be cast aside at once. I am unfortunately bound to admit that although judgment must be used in this matter, there is always a fair amount of chance in hitting off the right degree of density.

The black stain of the iron-hæmatoxylin completely masks the initial methyl-blue stain, and the difficulty of obtaining the correct point of differentiation of the iron-hæmatoxylin stain when that part of the process is nearing completion is greatly increased by the deep blue coloration which soon comes into play as the black

stain is being discharged by the second bath in the iron solution. This latter should be about one-sixth to one-eighth of the strength of the mordant, in order that it may be slow in action. Take plenty of time and use careful judgment, examining the sections from time to time under the Microscope. When satisfied that the correct stage has been reached, wash carefully in gently running tap-water for about a quarter of an hour to twenty minutes. The sections on the cover-glass are now dipped once or twice in upgrade alcohols 30, 50, 70, 90 p.c., differentiating the methyl-blue in the last grade of spirit when necessary. This must be done very carefully and to a great nicety, and under a not less than $\frac{1}{4}$-in. objective.

This latter remark applies equally when the differentiation of the hæmatoxylin is being effected.

Upon the completion of the differentiation, the sections are transferred direct into oil terpineol and allowed to remain about 10 minutes, or until perfectly cleared, and then mounted in

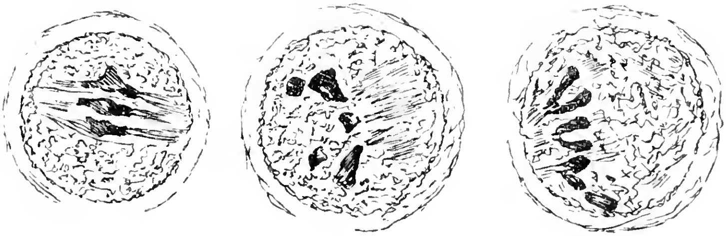


Fig. 15.

paroleine. Although the methyl-blue stain is not permanent in paroleine, used as the mountant, it lasts much longer than it does in balsam. This is the first instance that has yet come under my notice, since using paroleine as a mountant, in which it has failed to preserve or retain an aniline dye.

There are doubtless many microscopists who would follow some branch of cytological research, were there not an almost general impression that such work requires much skill and delicate manipulation, which deters them from taking up the work.

Surely all branches of microscopical technique, manipulation, etc., and the interpretations to be drawn from the same, must of necessity require due care and skill, but certainly cytology makes no demands that should deter many who would like to enter this field from so doing, and I trust that the above description of my method is lucid enough to stimulate would-be workers to action, not to repel them.

Although many points regarding microscopical technique and manipulation are somewhat difficult of explanation in a written

paper, and may appear to many insufficiently trustworthy and simple to follow, I would emphasize the statement that it only requires a worker to make a start in order to convince himself that this is certainly not always the case. Here we certainly have an important method and subject, and I feel sure that anyone who will follow them up will be amply rewarded.

In giving the description of the newly disclosed structure to which I have already referred, I find it difficult to decide on a name or term to assign to it.

Up to the present, for want of a more applicable or appropriate term, I have made use of the word "structure," but now, for the purpose of this paper, I shall use the term "chromatin extensions."

In order to fully understand these chromatic extensions and appreciate their possible value, and the part they may play in producing and controlling certain of the movements of the chromosomes, it is important that we should make ourselves familiar with the relation which the chromosomes and spindle fibres bear to each other, the theories concerning these structures which have at different times been put forward, and their various actions described at length, and the now accepted part played in the process of mitosis by the spindle fibres.

In connexion with these points, I would recommend those sufficiently interested in the subject to make a careful study of the plates given in Strasburger's "Practical Botany," translated by W. Hillhouse, M.A., etc., 1908 edition, pp. 442, 461, 463.

Although a little diagrammatic in one or two instances, they enable one to obtain a clear idea of the correct relations and position of the chromosomes and spindle fibres at metakinesis as well as graduating earlier and later stages.

It is generally believed by cytologists, and I think rightly so, that during metakinesis, as well as a little before and after the metakinetic stage, the chromosomes stain at their best, i.e. most intensely. Hence, when this is reinforced by my special method (as given above) of treating vegetable sections, not only the chromatin material is brought into a still further improved condition to receive stain (apart from its own specificity in this respect), but also—and here I claim a good advance upon former technique—the archoplasmic structure spindle fibres are also brought into a more favourable condition for taking up the stain.

As is well known, it is most difficult to get such structures to react with any kind of stain, and when they do, the amount of stain absorbed is so slight that it is scarcely appreciable.

It is recognized also that there may be two modes by which the chromosomes split or divide into two quite equal parts. I allude here to the splitting which takes place immediately following the definite arrangement of the chromosomes forming the equatorial cell plate (metakinesis), resulting after their reassembling at the

poles in the daughter nuclei, and it will not be out of place if I refer briefly to these two methods. The first, and certainly by far the most frequent, is that in which the splitting commences at the tip of the U- or V-shaped chromosome, and gradually proceeds down the entire length of the two arms or phalanges. The other method is that in which the splitting takes place in exactly the opposite direction; starting at the extreme ends of the arms or phalanges and proceeding up their entire length and finishing at the tip of the U or V. It is understood, of course, that the chromosomes are seen presenting their curved or pointed, and not the bifurcated, ends to the spindle fibres.

When the two newly separated ends of each pair of chromosomes make their appearance and are just moving apart from one another, one would quite legitimately ask the question, "What is the initiative force and the action in this process of separation?"

To this question we must, to be honest with ourselves, answer, "We do not know," and I can only refer again to the few remarks bearing upon this point I made in the earlier part of this paper, in which I refer to the different theories which have been put forward by various authorities.

I claim, however, as the result of my work and the application of my methods, that although I am no nearer being able to state what this initiative mechanism or force is in the process of separation and splitting of the chromosomes, I have been able, as careful consideration of my drawings and photographs of those small "chromatin extensions" shows, clearly brought them into view, as the result of successful staining of the spindle fibres; and it may materially help those who are in a better position than am I, to theorize as to their possible value or purpose in one of the most important processes of mitoses.

These chromatin extensions are first seen when the ends of the chromosomes have separated but a very short distance from each other at their apices, and the separated ends have a slight but appreciable tendency to turn away from one another towards their respective poles. As separation proceeds, they become more apparent and pronounced. On careful examination of figs. 1 to 6, Pl. IV, and A B C, text-fig. 15 (drawings from actual cells) small bead-like extensions are seen situated at the extreme tip of the U or V chromosomes. They are very small, and consequently may be easily overlooked unless careful searching be made; a $\frac{1}{12}$-in. oil-immersion is essential for their correct determination. They take the black stain of the iron-hæmatoxylin, and with the same intensity as the rest of the chromosome. An important point, and one well worthy of consideration, is that that portion of the spindle fibres (the whole of which stain a beautiful blue) in immediate contact with a bead-like extension of the chromosomes, stains much more deeply than that which is more remote, and we here

have the appearance of specialized ends. Another remarkable feature is that in suitable cases (see figs. D and B) it will be readily seen that the spindle fibres of each bundle, as they near the apex of each chromosome, converge, not to a single extremity, as has hitherto been depicted and described, but to a double end, one for each "chromatin extension" with which they are in apparent contact, though they do not, I believe, actually fuse.

In conclusion, it seems important from the foregoing to realize that due consideration should be given to the three following points of great interest :—

1. The chromatin extensions to be seen at the V-shaped extremity of each chromosome.

2. The double end of each bundle of spindle fibres, one directed to each chromatin extension.

3. The extra staining capacity of the ends of these spindle fibres.

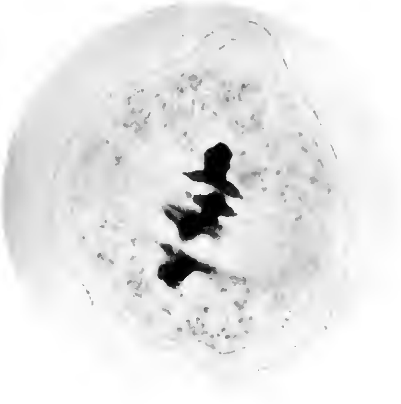
It would seem, perhaps, inadvisable to draw too hasty a conclusion as to which of these three very important details demands most attention, when considering what bearing they have upon or what their relation may be to the mechanism of mitosis.

I do not wish to pose for one moment as a physicist in the strict sense of the word, but I do feel inclined to ascribe the greatest weight and importance to No. 3 of the above items.

Relying not unduly upon the results of many of our present-day staining reactions, it may with safety be asserted that if a portion of a structure or tissue can be acted upon by a stain or staining process with a greater intensity, and also offer a greater resistance to differentiation or extraction of this stain, after the application of suitable means for this purpose, than the surrounding tissues, one may assume with some degree of certainty that the tissue so reacting possesses some special (may I say vital or organic?) functional capacity.

That the portion of the spindle fibres above mentioned does react in the specialized manner just referred to the methods given is, I think, conclusively demonstrated; and it but remains for us to attempt to work out the important question, "What force, vitality, or biochemical action can be hidden in so concentrated and minute a portion of the spindle fibre structure seen in mitosis?"

That the items No. 1 and 2 also possess undoubted significance must also be accepted, and each must latter receive its full mead of consideration.



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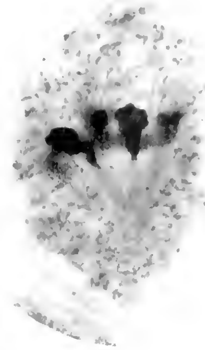

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D

SUMMARY OF CURRENT RESEARCHES

RELATING TO

ZOOLOGY AND BOTANY

(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),

MICROSCOPY, ETC.*

ZOOLOGY.

VERTEBRATA.

a. Embryology.†

Determination of Sex.‡—L. Doncaster has discussed the more important lines of evidence which bear on the problem of sex determination. Sex, although it is almost universally found, cannot be said with certainty to be a necessary attribute of living things, and its real nature remains an apparently impenetrable mystery. In the rare cases where it seems to have disappeared, the organism thrives to all appearance just as well without it. Perhaps the nearest approach to the deeper problems of sex is through the study of its determination.

The problems involved are concerned with existence of two distinct sexes and the causes which determine whether an egg will develop into a male or into a female, the comparative regularity with which they are produced, and the development of secondary sexual characters.

In fertilization we get almost our only definite indication of the ultimate nature and function of sex, for it implies the equal mingling in every individual of sets of inherited characters derived from two parents. Yet the two parents might have been similar and the sex-elements similar, somewhat after the fashion seen in *Paramecium* and the like. There is some advantage in the specialization of ova and spermatozoa along different lines, and this is associated with sex differences. But it is not certain whether the sex differences follow from a primary division into egg-producing and sperm-producing individuals, or whether the differences themselves are really primary, and lead to egg-production

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, etc., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so-called, but also those dealing with Evolution, Development, Reproduction, and allied subjects.

‡ The Determination of Sex. Cambridge (1914) 172 pp. (23 pls.).

in the female and sperm-production in the male as secondary consequences. It is interesting to speculate whether the characteristics of ovum and female, of spermatozoon and male, may not each be due to fundamental catabolic and anabolic tendencies, characteristic of maleness and femaleness, quite apart from the exigences of reproduction, as suggested by Geddes.

There have been three main opinions as to the true period of sex-determination, the oldest being that this takes place in embryonic life, while more recent investigations have pointed to the time of fertilization or before that. In *Phylloxera* and *Hydatina* two kinds of eggs are laid, which differ from one another in size, and the larger always produce females, the smaller males. The two kinds of eggs are laid by different parthenogenetic mothers, and the same distinction into male-producing and female-producing females is of wide, though not invariable occurrence in Aphids, Rotifers, and Cynipidæ. In the last two fertilized eggs always yield females, while parthenogenetic eggs are of two sorts, male-producing and female-producing. In Rotifers, an egg which would have yielded a male if unfertilized, produces a female if fertilized.

In regard to *Dinophilus*, it used to be believed that the two sizes of eggs both required fertilization, but the work of Shearer has shown that the larger female-producing eggs conjugate with a sperm-nucleus, while the smaller male-producing eggs do not. In the hive-bee and some other Hymenoptera unfertilized eggs develop into males. In some moths and birds the female transmits certain characters to her male offspring only: therefore there must be two kinds of eggs. In some Mammals (cat and man) the male transmits certain characters to the female offspring exclusively: therefore, according to Doncaster, there must be two kinds of spermatozoa.

The facts of "sex-limited inheritance" (notably in currant-moth, *Drosophila*, canary, cat, and man) seem to show that sex-determining factors are borne by the ova and spermatozoa, and that sex cannot be altered after fertilization. It is curious that some of the cases point to the egg being all-important as regards sex-determination, while others point to the spermatozoon. It is possible that sex is determined by an interaction of factors from the two parents.

The evidence is then adduced in support of the hypothesis that the presence of an unpaired or unequally paired chromosome is connected with sex-limited inheritance. It is not maintained, however, that the sex is determined simply and immediately by the presence or absence of a particular chromosome, for it may be that chromosomes are rather links in a chain of events, of which the determination of sex is only one.

If there are two kinds of spermatozoa in some types and two kinds of eggs in others, and if these two kinds are produced in equal numbers, as there is good reason to expect, the numbers of the sexes should be approximately equal. But the ratio at birth of males to females varies considerably. It may be that the proportions of the two kinds of eggs can be altered by environmental influences; it may be that the state of the germ-cells at fertilization is important; it may be that effects of

environment act on the egg after fertilization. Some of the experimental work on secondary sex-characters suggests the possibility of the sex of an embryo being modified after fertilization by an alteration in the physiological conditions.

In regard to secondary sex-characters, Doncaster suggests, as others have done, that each sex may have the potentiality of producing either male or female sexual characters, and that whether the one or the other set of characters appears depends on the particular kind of metabolism of the tissues concerned. It is important to distinguish between factors for sexual characters and for sex-determination. The inherited factors for the secondary sexual characters may be present in each sex, and the sex-determining factor may decide which shall appear. The problems of hermaphroditism and gynandromorphism are discussed in a special chapter.

The general conclusions of this interesting and luminous book may be briefly indicated. Many facts point to the reality of a sex-determining factor resident in the sex-chromosomes and inherited like any other Mendelian character (as was first suggested by Bateson and by Castle). Individuals which receive the factor from both parents would be of one sex, those to which it is transmitted by one parent only, of the other sex. But formidable difficulties are involved (1) in the evidence that the egg may influence the sex in cases in which observations on chromosomes indicate that the sex should be determined by the spermatozoon; and (2) in the evidence that the sex may be occasionally modified after fertilization by influences acting on the embryo or even later in life.

The author is inclined to give up the hypothesis of an unchangeable hereditary entity, the presence of which always causes one sex and its absence the other. He suggests that sex-determination depends on the reciprocal action between an inherited factor and its surroundings. Thus every germ-cell would bear a sex-determining factor, but when this factor has relatively small intensity of action, its effect may be counterbalanced by other causes which alter the physiological relation on which sex-determination depends. Certain extraneous conditions acting on the egg or early embryo may perhaps counteract the effect of the sex chromosome.

Age of Human Embryo.*—O. Grosser discusses the relation of ovulation and menstruation in the human female, in its bearing on the problem of determining the age of the young embryo. The literature of the subject is examined and compared, and the author concludes that the time of ovulation varies round a mean, which falls within the first pre-menstrual week. The duration of the tubal migration of the fertilized ovum is not eight to ten days as in many Mammals, but may be more than twenty and is normally at least fourteen. Implantation takes place most frequently in the pre-menstrual period, but is not limited to this.

Effect of Corpus Luteum Substance on Ovulation in Fowl.†
Raymond Pearl and Frank M. Surface find that the ovulation of an

* Anat. Anzeig., xlvii. (1914) pp. 264–83 (1 fig.).
† Journ. Biol. Chemistry, xix. (1914) pp. 263–78.

actively laying fowl is immediately inhibited by the injection in suspension, in proper dosage, of the desiccated fat-free substance of the corpus luteum of the cow. It has been shown by Loeb that one function of the well-developed corpus luteum in the Mammalian reproductive cycle is to inhibit ovulation. Its substance does the same in birds where there is nothing corresponding to the corpus luteum. The duration of this effect varies with different fowls from a few days up to two or three weeks. After the hen begins ovulating again the laying goes on unimpaired. The same effect is produced by the injection of extracts of the lutear substance, either intravenously or intra-abdominally. The active substance in producing the inhibition is inactivated by boiling. According to the authors the fact that the inhibiting function of the corpus luteum can be exercised in Birds as well as in Mammals, suggests that natural selection had nothing to do with the evolution of either the organ or the function in Mammals. But the argument does not appear to us to be convincing on this point.

Egg-production in the Domestic Fowl.*—R. Pearl and F. M. Surface publish the third part of their biometrical study of egg-production. The present paper deals with variation and correlation in the physical characters of the egg, and presents quantitative data, with a biometrical analysis of these, regarding the normal variation and correlation of the egg of the domestic fowl in respect primarily of size and shape. The material used was eggs of Barred Plymouth Rock pullets. The egg is relatively more variable in length than in breadth, and more variable in shape that in either of the linear dimensions, length or breadth. The weight of the egg and its volume are more variable than any of the other characters. There is a close agreement between the egg of the domestic fowl and the human skull, in respect of the degree of variation exhibited in the corresponding size and shape characters of the two structures. A consideration of the processes concerned in the production of the definitive size and shape of the egg and the skull suggests, though it does not prove, that this similarity in regard to variation constants is due to mechanical factors operative in both cases during the development and fixation of the final form. With the exception of breadth, all dimensional characters studied show significantly a symmetrical variation. All of the egg dimensions studied are correlated in varying degree. Intra-racially egg length and egg breadth are correlated only slightly. Neither the weight nor the volume of the egg is more than slightly correlated with its shape. Both length and breadth are significantly correlated with the weight and volume of the egg. The bulk measures (volume and weight) are more highly correlated with breadth than with length. The specific gravity of the egg exhibits only a very small degree of variation. The skull and egg show a correspondence in respect to the degree in which their chief dimensions are correlated. A comparison of the egg of the domestic fowl with those of a number of species of wild birds leads to the result that in general the eggs of wild birds are neither less nor more variable than those of the domestic fowl. The essential factors concerned in the determination of the degree of

* U.S. Dept. Agric., Bureau of Animal Industry, Bull. cx. pt. iii. (1914).

variation in size and shape of egg are probably purely physiological, and in no direct or immediate way, if at all, related to the action of natural selection. A study of intra-individual variation indicates that the relative variability of eggs is a definite characteristic of the individual.

Development and Evolution of Lungs.*—M. Makuschok has studied the development of the lungs in the nurse-frog, *Alytes obstetricans*, which agrees with other Amphibians investigated (frog, toad, newt, salamander, etc.). The primordia of the lungs appear as very minute depressions in the posterior portion of the branchial region. They never appear in *Alytes* before the completion of the fifth gill-pocket, but there are differences in this respect between the various Amphibian types. In the Axolotl the six pouches appear in order, and then the lung-primordia: in the newt the sixth pair of pouches and the lung-primordia appear almost simultaneously; in *Bombinator* the sixth pair appear after the lung-primordia. This may be because the sixth pair of pouches are soon reduced to mere vestiges—the post-branchial bodies, and it is well-known that vestigial structures tend to have a belated appearance in ontogeny.

The appearance of the lung-primordia after the sixth gill-pouch is what might be expected if the lungs are serially homologous with gill-pouches. Their early stages and their relation to the gut are closely alike. Soon after their appearance the lung-primodia are separated off from the branchial region—slowly in *Alytes*, quickly in other Amphibia. The post-branchial cavity becomes the laryngo-tracheal cavity, communicating with the definitive branchial cavity by a minute slit. This slit defines the posterior border of the branchial cavity and the anterior end of the œsophagus. If the lungs have had a developmental connexion with the hepatic diverticulum, they lose it when they are separated off from the gut.

The author supports Goette's view that the lungs are derivatives of the last (the seventh) pair of gill-pouches. He regards Crossopterygii and Dipnoi as types which remained by the way while their relatives (Pro-Pulmonata) pressed on towards terrestrial and tetrapodous and lung-breathing existence.

Development of Feathers.†—Raymond Pearl and Alice M. Boring have studied the regeneration of feathers, comparing the patterns in the regenerates and in the originals. In order to follow particular follicles they made tattoo circles round them. It is known that the barred pattern of some fowls, e.g. Barred Plymouth Rock, behaves in a clean-cut Mendelian manner, and seems to be represented by a single Mendelian factor or gene.

1. In the general body plumage a feather is not usually regenerated more than three times, the follicle remaining quiescent. Wing primaries have the maximum regenerative capacity.

2. A follicle that has been absolutely inactive for a long period (e.g. six months) preceding the natural autumn moult produces a new

* Anat. Anzeig., xlvi. (1914) pp. 497–514 (8 figs.).
† Science, xxxix. (1914) pp. 143–4.

feather in connexion with the moult, in the same manner as does any other follicle of the body. The process of moulting re-activates the follicle which has been brought into a quiscent state by successive feather removal.

3. The precise pattern is usually reproduced each time with extreme fidelity of detail. But if the feather is removed from the follicle as soon as it is fully grown, thus forcing continued regenerative activity, the pattern tends gradually to break up. Perhaps the pattern gene is represented in each follicle by a strictly limited amount of material.

4. The secondary sexual feathers of the male, such as the saddle hangers, only appear as adult plumage. The same follicles which produce these, produce as juvenile plumage only undifferentiated body feathers. If the juvenile feather be removed apart from the normal moult, the next feather produced by that follicle will be the secondary sexual feather, and not a feather of the juvenile type. After that all the regenerations are of the sexually differentiated feather.

Visceral Clefts in Chelonians.*—H. v. Alten has studied embryos of *Chrysemys marginata* with particular reference to the visceral clefts and the "branchiogenic" structures which arise from the epithelium of the clefts, namely thymus, "epithelial bodies," and supra-pericardial bodies. There are five pairs of branchial pouches and a paired diverticulum which is constricted off to form the supra-pericardial bodies. These are closely associated with the last two pairs of pouches, but are at first quite distinct. Later on, the wall of the gut forms a lateral diverticulum bearing the fourth and fifth pouch and the supra-pericardial body, so that the last looks almost like an appendix of the fifth pouch.

The first, second, and third pouches open to the exterior. The fourth comes close to the ectoderm, but no opening was seen. The first pouch forms a dorsal epithelial thickening in close relation to the facial ganglion, and it also forms a "branchial cleft organ." The second forms a dorsal epithelial thickening in close relation with the glossopharyngeal, and there is also a ventral diverticulum. The third forms a marked epithelial thickening in relation to the vagus, and a ventral diverticulum is constricted off. The close resemblance between the origin of the supra-pericardial bodies and that of the fourth and fifth branchial pouches leads the author to the view that there are six pairs of these pouches, as some maintain for Teleostei, Anura, Urodela, and Lacertilia.

Brooding Instinct in the Domestic Fowl.†—R. Pearl publishes an account of observations on the brooding instinct of the domestic fowl in its relation to egg-production. Broodiness normally constitutes one element in the cyclical reproductive activities of the female. It recurs with greater or less regularity following periods of laying. The degree of intensity of the brooding instinct, both in respect of its objective manifestations and of its physiological basis, may vary considerably at

* Ber. Nat. Ges. Freiburg, xx. (1914) pp. xcix–cv.
† Journ. Animal Behaviour, iv. (1914) pp. 266–88.

different times in the life of the same individual. Broodiness in the domestic fowl is not necessarily connected with any particular season, and though it is usually preceded by the laying of a "clutch" of eggs, it is not necessarily so. Well-marked broodiness behaviour may in certain cases disappear very quickly. The manifestations of the brooding instinct are apparently closely connected with the functional activity of the ovary, though the precise nature of the connexion has not been analysed.

Abnormal Hen's Egg.*—F. E. Chidester described a curious gourd-shaped egg, which had a constricted yolk. It is regarded as probably due to a constricted oviduct rather than to the fusion of two eggs during apposition induced by antiperistalsis. According to Parker, doubleness in eggs is due to an abnormal ovary, or to an abnormal oviduct, or to both combined. Cases of *ovum in ovo* may be due to antiperistalsis, but two ovarian follicles may combine. Féré claims that he succeeded in producing double eggs in a hen which normally laid single eggs, by drugging her with atropine sulphate.

Milky-white Jell in Axolotl Spawn.†—Arthur M. Banta and R. A. Gortner found a freshly-laid clump of the eggs of *Amblystoma punctatum* with milky-white instead of transparent jell. There was no evidence of bacterial decomposition. The outer and inner egg-membranes were transparent as usual and the imbibition of water was normal. The normal jell yielded 0·337 p.c. of dry material; the white jell yielded 0·361 p.c. The normal jell had an average of 8·32 p.c. of nitrogen; the white jell had an average of 9·18 p.c., in neither case corrected for ash material. The difference in nitrogen-content is in the same direction and of almost precisely the same amount that it would be if the opaque appearance were produced by an admixture of albumen with the mucin which composes the normal egg-jell.

Accessory Appendages in Amphibian Larva.‡—A. M. Banta and R. A. Gortner publish the results of some observations on accessory appendages and other abnormalities due to the action of centrifugal force on Amphibian larvæ. Eggs were treated in various stages from unsegmented eggs to the gastrula, and the paper describes the effects of the treatment on the earlier stages. At a stage when the blastopore had just become evident, a centrifugal force equal to 1700 times gravity killed most, but all that survived developed accessory tail-like appendages. A force of 1350 times gravity killed very few, and the survivors all showed accessory appendages. Treatment applied earlier than the blastula stage, or at the advanced gastrula and later stages, produced no abnormalities. There was usually only one accessory appendage to each animal, though as many as four were noted. The appendages were usually lateral, or even dorso-lateral in position; they were distinctly tail-like, and the myomere structure could be seen even when there were

* Amer. Naturalist, xlix. (1915) pp. 49–51 (2 figs.).
† Biol. Bull., xxvii. (1914) pp. 259–61 (1 fig.).
‡ Proc. Soc. Exper. Biol. and Med., xi. (1914) pp. 177–8.

no fin-like margins. Interpretation of these and other abnormalities is left for a larger paper.

Inbreeding.*—H. S. Jennings gives a general formula for the rate at which organisms become homozygotic through continued brother and sister mating. The formula gives (1) the proportion of individuals that will be homozygotic for any given character after any number of unbroken generations of such inbreeding; and (2) the average proportion of the characters of a given individual that will be homozygotic after any number of unbroken generations of such inbreeding. The numerical value obtained may be called the coefficient of homozygosis.

Let x = the coefficient of homozygosis; n = the number of inbred generations (the number of times successive brother and sister mating has occurred); f_1, f_2, f_3, etc. = the successive terms of the Fibonacci series (thus $f_1 = 0$, $f_2 = 1$, etc.). Then the formula for the coefficient of homozygosis is—

$$x = \frac{2^{n-1} + f_1 \cdot 2^{n-2} + f_2 \cdot 2^{n-3}}{2^n} \quad . \quad . \quad .$$

The coefficient of inbreeding on the same lines (brother and sister mating) is $\frac{2^n - 2}{2^n}$. The coefficient of inbreeding in self-fertilization is $\frac{2^n - 1}{2^n}$, and the coefficient of homozygosis is the same. The coefficient of inbreeding in cousin matings is $\frac{2^{n-1} - 2}{2^n}$; in parent and offspring matings $\frac{2^n - n - 1}{2^n}$.

Inbreeding.†—Raymond Pearl points out that the values of the coefficients of inbreeding for a particular pedigree are composed of the following elements: (1) the occurrence of the same individual animals more than once on the sire's side of the pedigree only; (2) the occurrence of the same individual animals more than once on the dam's side of the pedigree only; and (3) the re-appearance of animals which appear first on one side of the pedigree (either the sire's side or the dam's side) on the other side. The occurrence of (3) means that sire and dam are in some degree related, and the question arises what portion of the observed inbreeding is due to this. It appears that an individual may be inbred in ten generations to within two-tenths of one per cent as intensely, measured by the coefficients of inbreeding, if his sire and dam are in no way related, as he would be if his sire and dam were brother and sister. But clearly the germinal constitution of the individual produced would, except by the most remote chance, be quite different in the two cases. Pearl suggests a method for measuring the proportion due to kinship of the parents, and that due to earlier reduplication.

* Amer. Naturalist, xliii. (1914) pp. 693–6.
† Amer. Naturalist, xlviii. (1914) pp. 513–23 (2 figs.).

Hybridism between Cockatoos.*—Ernest Warren describes two hybrids between *Cacatua galerita* (male) and *Licmetis nasica* (female). Actual pairing was observed. Out of seven eggs, laid in three separate years, only two hatched. The hybrids stand between the two parents, but somewhat nearer to *Cacatua* than to *Licmetis*; they illustrate the blending of characters. Out of ten characters the hybrid is nearer to *Cacatua* in five, nearer to *Licmetis* in one, and almost exactly intermediate in four. In every character examined, with the possible exception of the coloured and non-coloured lores, there is a very obvious blending of the male and female characteristics; and although the external appearance of any hybrid is not to be regarded as an absolute guide to its inherent gametic character, the evidence, so far as it goes, points to a real blending of the characters of the parents, and the probable absence of so-called gametic purity, or the segregation of characters in their sexual elements.

Hybridization Experiments on Fishes.†—Günther and Paula Hertwig have made a number of crosses, the varied results of which are interpretable in terms of O. Hertwig's theory of different degrees of idioplasmatic disharmony between the paternal and maternal nuclei.

Nearly related forms, e.g. *Gobius jozo* and *G. capito*, may be crossed successfully and the viable though weakly offspring may be hatched. But a crossing of *G. jozo* or *G. capito* and *Crenilabrus pavo* results in the death of the developing ovum in the blastoderm stage or at the commencement of gastrulation.

Reciprocal crosses do not always yield the same results. Thus all the ova of *Crenilabrus pavo* fertilized with sperms from a species of *Gobius* die at the blastula stage, while the reciprocal hybridization results in embryonic stages which attain to gastrulation of a pathological sort. It is therefore necessary to recognize that the specific structure of the germ-cells (the nature of the ovum-cytoplasm and deutoplasm) must be taken into account. But the authors are not inclined to depart from the doctrine of Hertwig and Strasburger that the idioplasm is nuclear.

Development of Pronephric Duct in Elasmobranchs.‡—George A. Bates has enquired into this much-investigated subject, his material being *Acanthias* embryos prepared by the vom Rath picro-osmo-platinic method which renders cell-outlines and limiting membranes very distinct, and makes it possible to differentiate between different cells and cell-layers. This is all-important, for the main question is whether the duct takes its origin in whole or in part from the mesoderm, or whether it arises from or is contributed to by the ectoderm. The result of the enquiry is to show that the primordium of the duct is a direct outgrowth from the pronephros, and therefore mesodermic in origin, that its subsequent growth is accomplished by the division of its own cells, and that

* Annals Natal Museum, iii. (1914) pp. 7–28 (1 pl.).
† Arch. Mikr. Anat., 2te Abth. lxxxiv. (1914) pp. 94–88 (1 pl.).
‡ Journ. Morphol., xxv. (1914) pp. 345–72 (5 pls.). See also Tufts College Studies, iv. (1914) No. 2, pp. 345–72 (5 pls.).

it nowise receives contributions of cells from the ectoderm. It seems clear that the duct is not developed from an ectodermic groove. If the nephridia of Vertebrates ever opened to the surface through ectodermic pores, and later into a canal arising from the ectoderm, ontogeny has failed to repeat phylogeny in *Acanthias*, for there is no hint of such a condition in the development.

Experiments on Amphibian Ova.*—R. A. Gortner and A. M. Banta have tried the effect of dilute solutions of certain phenolic compounds on eggs of Amphibians, with particular reference to pigmentation and toxicity. It seems that black melanic pigment results from the interaction of an oxidizing enzyme of the tyrosinase type with some oxidizable chromogen, the exact nature of which has not been ascertained. Gortner has shown that *m*-di-hydroxyphenols inhibit the action of tyrosinase in vitro, and it is suggested that certain types of colourless animals owe their lack of pigment to the presence of inhibitory compounds. Gortner and Banta find that orcinol in 0·05–0·01 p.c. concentration produces retardation in growth and considerable retardation in pigment development. Resorcinol is even more effective. Tyrosin is, at most, only slightly toxic at saturation (0·04 p.c.). Bacterial infections are very common and make the solution sufficiently toxic to slightly retard development and occasionally reduce pigmentation. In most cases a marked increase in pigmentation occurred when the embryos were kept in solution of tyrosin of 0·01–0·04 p.c. concentration during and after the onset of pigmentation. To give one other example, tyrosol in concentration as great as 0·05 p.c. retarded growth and pigmentation, and killed *Spelerpes* larvæ within 15 days. Weaker solution retarded growth and pigmentation, but did not prove fatal, and in time the animals developed the usual amount of pigment.

Sex Ratio among Jews.†—Raymond Pearl and R. N. Salaman discuss the possible connexion between the time of the fertilization of the ovum and the sex ratio. The sex ratio among Jews sometimes shows a marked preponderance of males, e.g. among Russian Jews, 1459 per thousand in 1893, 1331 in 1897, 1295 in 1901. It may be that there is negligence in recording the births of daughters. Pearl and Salaman have enquired into a possible connexion with the time of fertilization of the ovum relative to the catamenial period (very strictly fenced off by Jewish regulations), and find no evidence of this. The higher male sex-ratio shown by the general Jewish statistics, if not due to faulty registration, must owe its origin to other factors than the time of the fertilization of the egg. The results leave open the question of the possible importance of the metabolic condition of the germ-cells at the time of fertilization. The distribution of ovulation over the intermenstrual period in the human female is so wide as to preclude any possibility of forming any judgment as to the relative age of discharged ova, on the basis of the time of menstruation.

* Biochemical Bulletin, iii. (1914) pp. 357–68.
† Amer. Anthropologist, xv. (1913) pp. 668–74.

b. Histology.

Endoplasm and Exoplasm.*—F. K. Studnička has studied in the notochord of *Belone acus* and in the dental papillæ of the horse, cellular processes which throw light on the formation of the endoplasm or dentendoplasma on the one hand and on the nature of the ectoplasm (individual ectoplasm as contrasted with synexoplasm) on the other.

Plasmic Structures.†—Julius Arnold, one of the veteran cytologists, has collected his chief observations and conclusions in a book. He discusses plasmosomes and chondriosomes, mitosomes and mitochondria, and shows that cellular pathology and physiology must be deepened by a recognition of the importance of the granula. The independence of the microsomes is limited, and though their role is sometimes quite definite, there are pathological and normal processes which demand a recognition of the co-ordinated life of the cell as a whole.

Movements of Melanophores of Frog.‡—S. J. Holmes publishes the results of a further series of observations on the reactions and movements of isolated melanophores of the frog. He finds that black pigment cells in tissues from the frog cultivated in lymph or plasma sometimes wander out free from other cells. The pigment cells show a typical amœboid movement, and may creep to a considerable distance. The smaller melanophores are relatively more active, and become isolated more often than the larger ones. Processes may be formed that are mostly free from pigment, and pigment may flow back and forward within cell processes. The changes observed in the pigmentation of the chromatophores are partly due to variation in the distribution of pigment within the cell, and partly due to changes in the outline of the cell itself. Heat causes a withdrawal of cell processes. Light has very little influence in the movements or state of contraction of the melanophores. Pigment-cells show a positive thigmotaxis, the newly formed pseudopods being adhesive to solid bodies.

Chondriosomes of Cartilage Cells.§—Luigi Torraca has studied these in the newt's tail during the process of regeneration. Some of the cells of the blastema along the axis of the regenerating bud are transformed into chondrioblasts. During this transformation the chondriokonts increase in length and thickness and number. The staining reactions change.

In the mitosis of the cartilage cells the chondriome does not seem to participate actively. During the karyokinesis the mitochondria seem more numerous than chondriokonts, but these do not completely disappear. When the nucleus passes into a resting stage the chondriokonts again predominate.

When the ossification of the vertebræ begins, the cartilage cells

* Anat. Anzeig., xlv. (1914) pp. 438–58 (27 figs.).

† Ueber Plasmastrukturen und ihre funktionelle Bedeutung. Jena, 1914, xviii and 471 pp. (4 pls.). See also Anat. Anzeig., xlvii. (1914) pp. 367–8.

‡ Univ. California Publications (Zool.) xii. (1914) pp. 167–74 (1 pl.).

§ Anat. Anzeig., xlv. (1914) pp. 459–74 (5 figs.).

begin to undergo retrogression and disappear. In these cells the chondriome shows disintegrative phenomena which lead on to a fragmentation of the chondriokonts and the gradual disappearance of the residual granules. In the degeneration of the other cell-structures, the chondriome is also destructively affected, undergoing rupture or solution.

Taste-buds of Rabbit's Tongue.* — Martin Heidenhain describes the minute structure of the papilla foliata of the rabbit, a pear-shaped or oval area with about sixteen ridges. Each ridge has a very variable median lamella of connective tissue and two approximately constant lateral lamellæ. The taste-buds in a series on each side of a ridge communicate with the epithelial grooves between the ridges. The buds are embedded in the layered flat epithelium of the buccal cavity, and to each there extends a minute canal from the surface. This canal ends in a slight enlargement or ampulla at the outer end of each bud. The bud consists of covering cells and sensory cells connected by intermediate forms. The basal cells described by Hermann in the depths of the bud, are elements of the indifferent intergemmal epithelium. The buds are mostly arranged in the sensory area in transverse rows, perpendicular to the surface of the tongue; they vary greatly in size; all the largest have two or three pores. During development division-processes seem to occur, so that one bud becomes two, and the buds with several pores are fixed stages in the process.

Ganglion Cells in Palatine Tonsil of Man.† — Gaspare Alagna calls attention to the presence of ganglion cells associated with a nerve branch in the palatine tonsil in man.

Nerve Cells in Human Epidermis.‡ — Gösta Häggqvist describes much-branched cells in the epidermis and at the boundary-line between corium and epidermis. They probably correspond to the cells of Langerhans. From the cells between the connective tissue and the epidermis numerous processes extend into the epidermis and branch there repeatedly. Some of the branches are connected with other branched cells: some end freely between the epithelial cells. The cells forming a second row beyond the corium boundary may be connected with a third row. They perhaps represent a primitive set of epidermic sensory cells.

Scleral Cartilage of Urodela.§ — Fr. Stadtmüller discusses in a preliminary paper the occurrence and significance of scleral cartilage elements in Urodela. He expresses the view that the state of the scleral cartilage is influenced by the conditions of life. Thus it persists in permanently aquatic forms, such as *Proteus*, *Menobranchus*, *Siredon*, *Cryptobranchus*, and *Menopoma* (which sometimes goes on land for a short time). It is variable in the typically amphibious *Amblystoma*, *Typhlomolge*, and *Triton*. It is absent, according to Eigenmann, in the

* Anat. Anzeig., xlv. (1914) pp. 385–405 (16 figs.).
† Anat. Anzeig., xlvii. (1914) pp. 283–5 (2 figs.).
‡ Anat. Anzeig., xlvii. (1914) pp. 285–8 (3 figs.).
§ Ber. Nat. Ges. Freiburg, xx. (1914) pp. cvi–cvii.

blind cave newt (*Typhlotriton spelæus*), but it is also absent in adults of *Salamandra maculosa*, *S. atra*, and *Salamandrina perspicillata*, where the eye is not rudimentary. In cases where the larvæ are aquatic and the adults terrestrial (*Salamandra*, *Salamandrina*, etc.), the scleral cartilage is present in the larval stage (so far as is known) and absent in the adults.

Minute Structure of Penis and Glans in Lemurs.*—Éd. Retterer and H. Neuville, continuing their comparative study of the external male genitalia, deal with the penis of the Aye-Aye, *Lemur catta*, *L. mongoz*, and *Galago*. The glans is free in Aye-Aye and Lemur; in *Galago* it is united by a frenum to the prepuce. There is a bone in the penis or the glans in the Aye-Aye and Lemurs; there is none in *Galago* where the corpora cavernosa are adipose as in many Feline animals. There is little foundation for the view that the glans is a swelling or distal expansion of the corpus spongiosum. Three-fourths or five-sixths of the glans (the pubic or dorsal portion) represent the distal end of the corpora cavernosa and their integumentary envelope. The remainder (the ventral or rectal portion) corresponds to the corpus spongiosum of the urethra, which itself results from a fusion of the two folds of the corpora cavernosa.

c. General.

Distribution and the Origin of Species.†—Asa C. Chandler has enquired into the relation between the extent of distribution and "speciation." His facts relate to mammals, birds, reptiles, amphibians, insects, and amphipods. As the range of a group of animals is extended, the species increase out of proportion to the genera, the genera out of proportion to the families, and the families out of proportion to the orders. Allowing for explicable exceptions, the increase in number of lower systematic groups out of proportion to increase of higher systematic groups as the area considered is enlarged, is a remarkably constant and widespread phenomenon. The author shows how the phenomenon may be theoretically explained in terms of isolation, the time element, and the causes of specific and generic transformation.

Scales of Heterodontus francisci.‡—J. Frank Daniel has made a minute study of the scales of this Californian shark. The ventrals may be distinguished from the dorsals. The ventrals on side view are not unlike helmets. Various types occur, such as the stomodæal denticles. A dorsal scale, seen from above, presents the appearance of a Greek cross, upon which an unusually high and sharp-pointed spine arises. Various types occur, such as the supra-orbitals and the anchor scales at the base of the pelvic fins and behind the cloaca. The study of transition areas leads to the conclusion that the dorsal and ventral scales represent distinct types with structural differences dependent largely on the location of the scale. In other words, an indifferent scale may

* C.R. Soc. Biol. Paris, lxxvii. (1914) pp. 509–12.
† Amer. Naturalist, xlviii. (1914) pp. 129–60.
‡ Univ. California Publications (Zool.) xiii. (1914) pp. 147–66 (2 pls. and 4 figs.).

become a dorsal or a ventral according to conditions of pressure. Scales differ according to time of origin, some being embryonic and some secondary. They also differ according to function, as is illustrated by the marginals, which become large in exposed situations. The young scale, after the tip has perforated the skin, is very plastic. The exposed supra-orbitals tend to hypertrophy; the stomodaeal scales tend to atrophy.

Responses of Sessile and Motile Organisms.*—Victor E. Shelford enquires into the different kinds of response in sessile and motile organisms. By responses he means reactions, changes in function and structure induced by external conditions, whether directly or indirectly, quickly or slowly. Thus motile organisms may change their position, colour, etc.; and sessile organisms may grow in a particular way or adjust their body in relation to a stimulus. Mobile organisms tend largely to behaviour responses, and sessile organisms rather to structural responses. The author emphasizes the need of considering all sorts of responses of both sessile and motile organisms if an adequate theory is to be established.

Theory of Malignant Tumours.†—Th. Boveri suggested in 1902 that malignant tumours might be the result of an abnormal condition of the chromosomes, as, for instance, in pluripolar mitoses. Aichel has sought to combine this suggestion with another, that the beginning of the tumour may be the coalescence of a leucocyte and a tissue cell. But Boveri adheres to his view that the malignant cells result from some nuclear or chromosome defect which they cannot remedy. He passes from cellular to nuclear pathology.

Effects of Temperature on Tropical Marine Animals.‡—A. G. Mayer has experimented on corals and medusæ as to their death-temperatures. Reef corals, in common with other marine animals, live at temperatures within about 5° of their temperature of maximum activity and within 10° of their death-temperatures. The factor of safety in respect to elevation of temperature is far less in tropical than in temperate marine animals. They are, relatively speaking, poorly adjusted in a physiological sense to their temperature environment. Slight differences produce more serious effects than in the marine animals of the temperate regions. Moreover, tropical marine animals can withstand cooling better than they can survive heating above their normal life-temperature. High temperature appears to cause asphyxiation, the oxygen in the water being insufficient to support the intensified metabolism.

Feet of Bats.§—F. De Fenis has made a study of the different types of foot in Chiroptera and the various adaptations exhibited. He recognizes four types:—(*a*) the adaptation to suspension is at a minimum.

* Amer. Naturalist, xliii. (1914) pp. 641–74.

† Zur Frage der Entstehung maligner Tumoren. Jena (1914) 64 pp. See also Anat. Anzeig., xlv. (1914) pp. 477–8.

‡ Carnegie Inst. Washington Publications, No. 183 (1914) pp. 1–24 (8 figs.).

§ Arch. Zool. Expér., liv. (1914) pp. 195–220 (11 figs.).

and there is a power of bipedal progression, e.g. in *Chiromeles*; (*b*) the adaptation to suspension is in the callosities or an adhesive disk on the plantar surface, e.g. *Thyropoda* and *Myxopoda*; (*c*) the points of the claws adhere to roughnesses on the rocks, e.g. *Carollia*; and (*d*) the suspension is effected by the long curved claws which grip the branches like hooks.

INVERTEBRATA.

Mollusca.

Fresh-water Molluscs of Celebes.*—G. Bollinger makes a report on a collection of molluscs—mostly of small size—from Lindu-lake in Central Celebes. He records thirteen species, of which four are new, *Bythinia sarasinorum*, *Isidora badæ*, *Planorbis sarasinorum*, and *P. badæ*. There is also *Isidora sarasinorum* sp. n. from the south-east of the island. A consideration of the collection points to the conclusion that the molluscs of the basin in question have been derived from all sides and represent a markedly mixed fauna.

γ. Gastropoda.

Development of Periwinkle.†—H. C. Delsman gives an account of the development of *Littorina obtusata*, one of the common periwinkles. The eggs are laid in clumps on the fronds of *Fucus serratus*, and the development lasts (in September) for fully three weeks. The diameter of the unfertilized ovum is about 205 μ; two maturation divisions occur and after their completion two approximately similar nuclei are seen in the egg. The first cleavage results in two equal cells, and the second likewise. The third cleavage is unequal and "dexiotropic" (as is the rule in Gasteropods with right-handed spiral shells); four macromeres (endodermic) are separated from four micromeres. The next establishes the primary trochoblasts or "turret-cells"; the next the third quartette; the next the mesentoblasts; and so on. In the 49-cell stage there are 7 endomeres, 2 mesentoblasts, and 40 ectomeres, but it is difficult to picture their relations without the diagrams. The end of the segmentation is a disk-like plakula of about 150 cells, the endomeres being flattened out. Perhaps this should be regarded as the first step in the gastrulation, which is very suggestive of that of lancelets.

After the completion of the gastrula there is a remarkable change of form, and the development of the veliger begins. The shell-gland is seen very early, but there is no trace of the head vesicle which has been observed in *Fusus*, *Nassa*, *Crepidula*, *Calyptræa*, etc., and has a respiratory function. Perhaps the fact that the eggs are fastened to seaweed in the surf-zone may explain the absence of any special respiratory provision at this stage. There is no podocyst or yolk-mass, and the structure of the veliger, with its foot, velum, stomodæum, and so on, is

* Rev. Suisse Zool., xxii. (1914) pp. 557–79 (1 pl.).
† Tijdschr. Nederland. Dierk. Ver., xiii. (1914) pp. 170–340 (10 pls.).

clear and typical. The development of these structures is described in detail, and the author goes on to that of the tongue and radula. Special attention is given to the chordoid tissue of the tongue. It seems probable that the musculature of the tongue has a common origin with the columellar musculature, from which also that of the creeping foot is subsequently derived.

Attention is directed to two transient structures—the "nephrocysts" and the larval heart. The nephrocysts are two very large cells, one on each side of the gullet in the primary body-cavity. The larval heart is a thin-walled portion of the body-wall, in the mantle cavity behind the velum, which pulsates vigorously long before the definitive heart is formed. The invaginated endoderm cells differentiate into stomach, liver, and intestine. The hind part of the intestine appears to be endodermic. From the first the primordium of the liver is unpaired and dorsal.

The sense-organs appear before the nervous system. The statocysts arise from a minute ectodermic proliferation of the epithelium of the foot behind the mouth. Very similar is the origin of the eyes. Between the two lobes of the velum and the apical cell-plate, on each side of the latter, there is a group of small cells, which retain for a time an embryonic character, and include the primordia of tentacles, eyes, and cerebral ganglia. A detailed account is given of the development of the nervous system. That of the heart, kidney, and gonads is more provisionally described. The shell and the mantle, the torsion and the asymmetry are also dealt with.

Acroloxus lacustris.*—E. Popple, in recording the occurrence of this fresh-water Gasteropod in Hertfordshire, compares it with the much commoner *Ancylus fluviatilis*. In the latter the shell is rather round and elevated, the beak blunt and turned to the right. In the former the shell is oblong and depressed, the beak sharp and turned to the left. The usual habitat of *Ancylus* is on stones in running water, while *Acroloxus* is generally found on leaves of aquatic plants in still water. "Apart from the above differences it is found on examining the body of *Ancylus fluviatilis* that the important organs are situated on the left side, whereas in *Acroloxus lacustris* they are placed on the right side of the body." In *Ancylus* there are 120 rows of 37 teeth on the radula, in *Acroloxus* 75 rows of 39 teeth.

Arthropoda.

Olfactory Sense in Hymenoptera and Spiders.†—N. E. McIndoo has made numerous experiments with ants, bees, hornets, and spiders in reference to the sense of smell. The odours used were such as oil of peppermint, thyme, winter green, clove, and bergamot. When the pedipalps of spiders are removed the behaviour remains normal, and the reaction time is practically the same as when intact individuals are tested. But when the antennæ of Hymenoptera are mutilated in the

* Trans. Hertfordshire Nat. Hist. Soc., xv. (1915) p. 240.
† Smithsonian Misc. Coll., lxiii. (1914) No. 9, pp. 1-63.

slightest degree, the behaviour is abnormal, and the reaction times are slower than when intact individuals are used. It may be, however, that the slowness is due to the abnormal behaviour of the insects and not to the fact that some of the olfactory structures are kept from functioning.

When the cheliceræ of spiders are removed, no abnormal behaviour is observed. The reverse is the case when the maxillæ of bees are removed. In both cases the reaction time is slightly slower. When the mouth-parts of honey bees are mutilated the behaviour of the insects is abnormal and the reaction times are slightly increased. This may be due to the abnormal behaviour of the insects, or to the fact that the pores on the mouth-parts are prevented from functioning, or to both conditions combined. The removal of the wings increases the reaction times. When the pores on the wings are covered with glue the reaction times are much increased. When most of the pores on the legs are covered with vaseline the reaction times are greatly increased. When spiders or Hymenoptera are so injured that most of the olfactory pores are prevented from functioning, the reaction times are greatly increased, even when the behaviour is otherwise quite normal.

When the antennæ of any insect are injured the behaviour is no longer normal, and the failure of the insect to respond to odours near it does not prove that the seat of smell is in the antennæ. It must be noted that cutting the antennæ exposes a large nerve and many sense cells. The insect is no longer normal in its behaviour, and in some cases the injury is rapidly fatal.

The author considers the structure of the antennæ in reference to the widespread view that the sense of smell is located there. In the honey bee the pore plates can scarcely be considered as olfactory organs, for the drone has almost eight times as many as the queen, and yet responds to the odours presented in slightly more than one half the time. It is true that those of the queen are considerably larger, but even on this basis the reaction times are not comparable.

The pegs may be entirely eliminated as olfactory organs, for they are absent in the drone, while they are abundant in the worker and the queen. Drones, queens, and workers have about the same number of Forel's flasks and pit pegs. Schenk's view that the pegs receive odour stimuli in the queens and workers, while Forel's flasks and the pit pegs function in this way in the drones is inconsistent, because if the last two structures function for such a purpose in the drones, why should they not do so in the females? Since these two structures are few in number and many times smaller than the pegs, we cannot compare them physiologically.

The author's argument is that the distribution of these antennary organs in the honey-bee does not correspond with the facts experimentally established as to the reaction times of the queens, workers, and drones when tried with the various odours. It is otherwise, however, with what the author calls olfactory pores. If the reaction time of each caste of bees is compared with the total number of olfactory pores, a consistent inverse ratio is observed. A drone has 2600 pores and responds in 2·9 seconds; a worker has 2200 pores and responds in 3·4 seconds; and a queen has 1800 pores and responds in 4·9 seconds.

Pore plates, pegs, Forel's flasks, pit pegs, and end rods have all been considered as olfactory organs by various authors. Pore plates cannot be the olfactory structures in all insects, for they are entirely absent in Lepidoptera. The pegs cannot be the olfactory structures in all insects, for they are absent in many male bees and almost wanting in Lepidoptera, although possibly the end rods in butterflies and moths are homologous. According to Vom Rath, pegs are found not only on the antennæ and mouth parts but also all over the body. Nagel also found them elsewhere than on the antennæ. If the pegs are the olfactory structures, and if insects from which the antennæ have been cut off are normal, the author asks why such insects do not respond positively, to a slight extent at least, to odours, instead of negatively as most observers claim.

Spiders can smell, yet they have no antennæ, and the author's negative conclusion is that the antennæ in Hymenoptera play no part in receiving odour stimuli. His positive conclusion is that the olfactory pores are the sensory structures. These olfactory pores were observed by Hicks in 1857, and called by him vesicles. He saw them on the bases of the wings, on the halteres, and on the legs of Diptera, on the bases of all four wings in other orders, on the trochanter and femur of all insects, and occasionally on the tibia. He observed the nerves going to them, and suggested that they were olfactory. They have also been studied by Janet.

McIndoo describes the various groups of pores in bees, on the bases of the wings, on the legs, on the sting, on the mouth-parts. For the legs of ants the number varies from 463 to 1090. The grand total for a drone bee is 2608, and that is the highest number observed. The olfactory pores consist of inverted flasks in the chitin and of spindle-like sense-cells lying beneath the mouths of the flasks. About two-thirds of the space at the bottom of the flask is occupied by a hollow chitinous cone, continuous with the cuticle. A sense fibre from the outer end of each sense-cell pierces the foot of the cone and enters the pore aperture, where its cytoplasm comes into direct contact with the air and the odorous particles. A fibre from the base of the sense-cell goes to a nerve. The author has no belief in odours getting through a continuous chitinous cuticle. In spiders Hicks's vesicles are represented by the slit-like lyriform organs first described by Bertkau. McIndoo finds them at the distal end of each joint of the legs, pedipalps, chelicerae; occasionally on the spinnerets and on the ventral surface of the body.

a. Insecta.

Myrmecophilous Organs of Larval Lycæna orion.*—R. Ehrhardt describes these interesting structures, which are of two kinds. On the dorsal surface of the caterpillar, in the middle of the 10th segment, there is a longitudinal slit. When this is titillated by the antennæ of an ant, it opens, two cushion-like lips are seen, and between them there appears a small drop of secretion which is greedily licked up by the ant. Besides this, there is on the 11th segment a scent-organ which

* Ber. Nat. Ges. Freiburg, xx. (1914) pp. xc–xcviii (9 figs.).

is of no direct use to the ants. There are two protrusible papillæ, with a terminal wreath of very fine hairs. When the caterpillar is touched by an ant the papillæ are protruded, and a scent attractive to ants is exhaled. The caterpillar is always attended by ants, who afford it protection. Ehrhardt finds that when the ant is touched by small centipedes or beetles, or the like, the scent-organs are protruded. But there was no secretion except when he held the centipede so that it touched only the area of the secreting organs with its antennæ and first pair of legs. By means of other stimuli, thermal and electrical, the protrusion of the papillæ and an activity of the secreting organs can be induced. Ehrhardt was able by using an electric current to get ten secretions in $1\frac{1}{2}$ minutes.

The secreting organ in the full-grown caterpillar consists of four secretory vesicles, which project far into the body-cavity and fill up the greater part of segments 9, 10, and 11; each consists of two giant cells, a pear-shaped one in contact with the slit, and a large irregular one beneath it, and acting as a reservoir. The external part of the pear-shaped cell is really closed, but the membrane is very delicate and protrusible. These remarkable cells probably correspond to the couple of cells found at the base of each of the hollow glandular hairs which are frequent on the skin. The lower one sends a plasmic strand through the upper one, and this strand secretes the chitinous hair.

The secretory organs of *Lycæna orion* do not appear until after the first moulting, and there are at first two. The development indicates that they are transformed glandular hairs, and the process is described. During the second moult the first two secretory vesicles are absorbed and two new ones are formed. In the next moult these are absorbed and four new ones are formed. The opening of the slit and the exudation of the secretion are due to blood pressure.

The scent-organs are not developed until after the second ecdysis. They are evaginations of the hypodermis. At the end of the evaginated papilla there is a circle of wart-like elevations, each with a very thin hollow seta, which, again, bears a spine-like process. Thus a large surface is formed for the exhalation of the scent. Each hair has a unicellular gland at its base with a very large nucleus, rich in chromatin. The protrusion is due to blood pressure; the retraction is brought about by a muscle attached to the apex of the papilla. The two kinds of organs disappear in the pupa state, and there is no trace of them in the adult.

Variations in Italian Lepidoptera.*—Roger Verity gives an account of a number of variations observed in Lepidoptera collected in Tuscany and other parts of Italy by O. Querci and himself. He deals with species of *Parnassius*, *Melitæa*, *Argynnis*, *Melanargia*, *Erebia*, *Epinephile*, *Cœnonympha*, *Thecla*, *Chrysophanus*, *Lycæna*, and *Syntomis*.

Nocturnal Observations on Ants.†—V. Cornetz relates some interesting observations on the way-finding of ants. Thus, in regard to a

* Bull. Soc. Entomol. Ital, xlv. (1914) pp. 203–38 (1 pl.).
† Rev. Suisse Zool., xxii. (1914) pp. 581–95.

species of *Myrmecocystus*, it seems that there are "recognition-points" distributed around the nest at a distance of 9 or 10 metres. These points are isolated, and there is something about them that evokes re-orientation. They may be points from which some finger-post associated with the still distant nest is perceived. But the difficulty is to discover how these points differ from others close beside them. In species of *Messor*, there was no evidence of any acquired knowledge of the region around the nest. Transported from near the nest to a distance of a yard they behaved as if in an unknown world. The theory that ants at a distance from the nest make use of the differential illumination of objects near the nest, requires to be carefully tested. Many ants have a very short range of direct perception, and their horizon is very near at hand. That some perceive big differences in distant illumination has been satisfactorily proved. Cornetz was led by these problems to make some observations in darkness.

When a track of *Tapinoma*, marked by odoriferous traces, is interrupted and washed across for 20 cm., it is restored in 15–20 minutes. The restoration begins by an ant crossing the gap in a definite and right direction, and in a confident manner. Is this because of an orientation in reference to the light in the sky? Cornetz covered a gap of 40 cm. with an opaque sheet, and found that no ant got across. But when he put the sheet over an uninterrupted march, he found that the march stopped. The stoppage is induced by the sudden cooling of the earth and the abrupt change from light to darkness. When the experiment was made in the twilight there was no stoppage, only a retardation and an interrupted march was reconstituted.

During the night Cornetz observed a track of *Tapinoma*, with 110 to 160 ants to 1 m., which extended between two houses for 18 to 20 metres. He made a gap of 3 to 4 m. and washed it. For three minutes there was a block at each side. Then a worker went straight across (as was seen by means of a dark lantern) and the march was restored in 15 to 18 minutes. The next evening he repeated the experiment, but covered the gap with a long wooden form, which shut out the stars (Cassiopeia). It made no difference to the result. Cornetz believes in a sense of direction to this extent, that these ants are able to go right on in the path which they were pursuing, though all the scent traces have been washed away, and though there is no illumination. He cannot defend his conclusion logically, but he is forced to a belief in the ant's memory of the position of the median plane of its body in space, and in a memory of the "direction" in which it was going.

New Miocene Coleoptera from Florissant.* — H. F. Wickham reports on part of a rich collection of beetles from the Florissant Shales. Scudder began the study in 1893 and described 210 species; Cockerell and Bentenmuelier have described 6; Wickham has described 172 new forms. The present paper includes 86 of these. It seems to be plain that the proportional development of the various coleopterous families during the Miocene times differed, sometimes very decidedly, from that obtaining to-day.

* Bull. Mus. Comp. Zool. Harvard, lviii. (1914) pp. 423–94 (16 pls.).

New Termitophilous Beetle.* — Ernest Warren describes a Staphylinid, *Corotoca akermanni* sp. n., found by Conrad Akermann in the nests of *Eutermes trinervius* near Pietermaritzburg. In some nests a beetle larva was found, but all attempts to rear it proved fruitless. The larva was comparatively common; the beetle appears to be excessively rare. It may be that the termites interfere injuriously with the pupa. The genus is highly specialized, and was based by Schiödte from Brazilian forms. This distribution indicates antiquity. The abdomen is much swollen and the greater portion is permanently turned forwards over the dorsal surface of the thorax as far as the middle of the pronotum. Trägårdh described a similar Staphylinid, *Termitomimus*, from Zululand.

Indian Mallophaga.†—V. L. Kellogg and J. H. Paine report on a collection of Mallophaga obtained from the skins of birds (mostly Indian crows, jays, and pheasants) in the Indian Museum. It is pointed out that records from dried skins are not very apt to be misleading. The danger of straggling is small because of the sedentary habits of the parasites and their early death after the host's death. Thirteen new species are described belonging to the genera *Goniocotes*, *Goniodes*, *Colpocephalum*, *Docophorus*, *Nirmus*, *Menopon*, and *Nitzschia*.

Phasgonurids of Tonkin.‡—J. Carl describes nine new species of these Orthoptera from Tonkin. He establishes a new genus *Parapsyra*, intermediate between *Calopsyra* and *Psyra*, and regarded as representing an ancient element in the fauna. The same may be said of *Trachyzulpha annulifera* sp. n., of which the only other known species is found on the Tengger Mountains in Java. This is a good example of discontinuous geographical distribution. On the whole the Orthoptera of Tonkin seems to be "young," consisting of endemic species of large genera with a wide geographical representation. The endemic nature of many of the species is related to the mountainous character of the country. The figures refer mainly to the external genital parts.

Beaded-winged Variation in Drosophila.§—John S. Dexter has studied a case that for some years seemed to defy Mendelian analysis, but has now yielded. Masking of a Mendelian ratio may be brought about by the presence of multiple factors, by environmental influence, or by the appearance of lethal characters. When a beaded fly is mated to one without the gene for beadedness a varying percentage of the F_1 offspring is beaded. If the male parent is beaded the majority of the beaded offspring are usually females, and if the female parent is beaded the majority of the beaded offspring are usually males. A female beaded fly, however, gives a larger percentage of beaded daughters than does a male beaded fly. It may be that the male offspring are somewhat influenced to or away from beadedness by the nature of the ovum-cytoplasm. Beaded wings showed no linkage to any sex-linked character.

* Ann. Natal Museum, iii. (1914) pp. 103–6.
† Records Indian Museum, x. (1914) pp. 217–43 (2 pls.).
‡ Rev. Suisse Zool., xxii. (1914) pp. 541–55 (12 figs.).
§ Amer. Naturalist, xliii. (1914) pp. 712–58 (12 figs.).

There is evidence that a larger percentage of the F_1 generation have beaded wings when the culture is wet and the food alkaline. There is also evidence of a gene which behaves as a lethal factor preventing the development of any fly that carries it in a homozygous condition. Whether the gene concerned in the production of beaded wings is dominant or recessive is determined probably by (1) the nature of the egg cytoplasm; (2) the presence or absence of the lethal gene: and (3) the nature of the environmental conditions.

Failure of Ether and Radium to produce Mutations in Drosophila.*—T. H. Morgan has enquired into the possibility that ether or radium may have brought about the mutations which he has observed in *Drosophila ampelophila*. In a total of 31,168 flies subjected to ether, there was not a single mutation observed, so that it seems safe to say that ether does not play the role of a specific agent causing the mutations. Experiments on a large scale in subjecting the flies to the emanations of an X-ray machine and of radium salts failed to produce any mutations, although the flies were made sterile for a time. At various times experiments have also been made with changes of temperature, salts, sugars, acids, and alkalis, without any resulting mutation. Guyénot also treated the fly to high temperatures, to radium, and to X-rays without result. Many mutants of *Drosophila* are known, but their occurrence seems to be very rare. They appear under conditions where all the other flies in the same culture are normal. But it is not known whether they are evoked by external influences, accidents of mitosis, hybridizing, changes in the chromosomes, or otherwise.

Apterous Drosophila.†—Charles W. Metz has studied the heredity of an apterous mutant of the fruit fly, *Drosophila ampelophila*. The apterous character is a simple Mendelian recessive, which independently mendelizes with miniature wings, white eyes and vermilion eyes, and hence is not sex-linked. The apterous factor is transmitted independently of the factor for pink eye. It is distinct from vestigial wing. It is closely linked to black.

The apterous mutant is not only entirely destitute of wings but has greatly reduced balancers. It is weak, sluggish, short-lived, and with a marked incapacity for reproduction. Germ-cells are produced normally, but the individuals evidently find it difficult to perform the reproductive processes.

No crosses were obtained between apterous and apterous, but each sex was successfully crossed with winged forms. The apterous female could produce only a few eggs.

Although many opportunities were given, no apterous form gave rise to a vigorous race. It seems that vigour and viability are directly associated with morphological characters, and are not to be separated from them by selection. In other words, the factor responsible for lack of wings is also responsible for physiological disturbances. The case shows that a factor may have far-reaching effects, and need not be

* Amer. Naturalist, xliii. (1914) pp. 705–11.
† Amer. Naturalist, xliii. (1914) pp. 675–92 (1 fig.).

limited to one part or organ. The final result of development is not due to the independent action of various factors and their products, but to the combined action, or the interaction of these products. The normal development of the wing is influenced by many factors, as is suggested by data derived from the various wing-mutations in this fruit-fly. One factor is responsible for miniature wings, another for vestigial, another for rudimentary, another for curved, and so on.

Early Stages of Paltostoma schineri.* — H. Scott describes the larvæ and pupæ, recently found in Trinidad, of *Paltostoma schineri*, one of the remarkable family of Blepharoceridæ or "net-winged midges." The species has hitherto been described from the male sex only. Female larvæ and pupæ are now described for the first time. The larva has short two-jointed antennæ; dorsal surface spinose; branchial filaments arranged in tufts; lateral processes simple, pediform, ciliate, without long setæ; sixth segment with only one pair of lateral processes. In the full-grown larva there are ten branchial filaments, arising in five pairs, in each tuft. In the half-grown larva the number is much less. A similar increase during growth has been observed in *Liponeura*. The larvæ and pupæ, described as those of the South African *Kellogina barnardi*, do actually belong to that species, in spite of doubts expressed on that point. The larvæ of *Kellogina* and *Paltostoma* have a number of points of resemblance, and both differ from *Curupira* in the arrangement of the branchial filaments. But in the possession of spines *Paltostoma* approaches *Curupira*. The pupa of *Paltostoma schineri* is characterized by the large number of erect spiniform hairs on its dorsal surface. The mouth-parts of the male conform to the general Blepharocerid type, but are characterized by extreme length and slenderness of labrum, hypopharynx, and labium, and by extreme reduction of the palpi, which are minute and at most two-jointed. The female has a much shorter, stouter proboscis, and palpi normally developed.

The paper includes a full description of the female imago by C. G. Lamb.

δ. Arachnida.

Life-cycle of a Spider.† — Jeanne Berland has made a study of *Uloborus plumipes*, a cribellate spider. It is a sun-loving creature, making a horizontal orbicular web between the Opuntia-stems at Banyuls-sur-Mer. When disturbed, it pays out a thread and sinks to the ground, where it is difficult to detect. Each ivory-white cocoon contains about fifty eggs, and is sedulously watched by the mother. The hatching was observed under a binocular, and the first moult, which immediately ensues. A compact group of young spiders remains around the empty cocoon for some days. The observer fed two hundred for six months first with Aphides and then with fruit-flies (*Drosophila*) whose legs had to be removed.

The young spiders make circular webs adjacent to one another, and

* Ann. and Mag. Nat. Hist., xv. (1915) pp. 181–202 (3 pls.)
† Arch. Zool. Expér., liv. (1914) Notes et Revue, No. 3 pp. 45–57 (9 figs.).

if a victim falls on the boundary-line, a struggle ensues. If the individual who claims the food is much molested by its neighbour, it will treat the neighbour as a second victim. The mother will eat the young ones if they stray on to her web.

The mortality of the young is enormous during the first three weeks. This is not due to fractricidal competition, but the cause is unknown. Some mortality is connected with moulting. There are five moults before the adult size is attained. When moulting is about to occur the spider remains immobile, does not spin, and does not eat. The cuticle cracks, the spider swings gently, and draws out its long limbs from their husks.

The young males make good webs; the adults eat less and make irregular webs. The adult life of the male is short — on an average two or three weeks. In the adults reared from eight cocoons there were twenty-nine males to fifty-two females. The pairing period is short. The females seem to choose. A male rejected one day was accepted next day by another female. The female may kill the male, winding silk around him and sucking his body, as is well known in some other spiders. The intricate sex-behaviour is carefully described.

Antarctic Pycnogonids.* — T. V. Hodgson makes a preliminary report on the Pycnogonida collected by the 'Gauss' in the Antarctic regions. The collection includes three new genera and twenty new species. In *Notoendeis* g.n., near *Colossendeis*, the body is perfectly segmented, with short and distinctly separated lateral processes, and with well-developed eyes: the proboscis is very large: the palps are nine-jointed, and the oviger is ten-jointed, with a terminal claw. In *Austropallene* g.n., there are large and stout cephalic spurs: the body is robust or slender, with distinct segmentation, with lateral processes close together or widely separated; the eyes are well-developed; the proboscis is tapering with or without a setose wreath: the cheliferi are stout, the chelæ short and powerful; there is no trace of palps: the ovigers are ten-jointed, without a terminal claw: there is a distal swelling on the fifth joint of the male; there are no auxiliary claws. In *Austrothea* g.n., are included *Ammothea*-like species with a body not discoid in any sense, and without the transverse ridges characteristic of the genus *Ammothea* in the strict sense. The legs are comparatively long.

ε. Crustacea.

Crustaceans from Mauritius.† — E. L. Bouvier calls attention to some interesting Crustaceans collected by M. Paul Carié on the coast of Mauritius. Thus there is the very rare Stomatopod *Gonodactylus* (*Protosquilla*) *guerini* White, of which only two specimens have been previously recorded. The Decapod *Ortmannia alluaudi* Bouvier has a mutation-form, *Atya serrata* Spence Bate, and there is probably a similar relation between *Ortmannia edwardsi* and *Caridina richtersi*. The small Palinurid, *Palinurellus wienecki* de Man, has only been seen

* Ann. Nat. Hist., xv. (1915) pp. 141–9.
† Comptes Rendus, clix. (1914) pp. 698–704.

thrice before, and not less rare is *Pseudibacus pfefferi* Miers, which appears to be the post-larval free-swimming form of a Scyllarid, probably *Scyllarides squammosus* Edw. Many other interesting forms occur in the collection.

Larval Stages of Palinurus.*—E. L. Bouvier gives an account of the phyllosoma-stages of *Palinurus vulgaris*, and of the transition from the phyllosoma to the puerulus. It appears that the rock-lobster does not pass through the curious phyllamphion stage described by Reinhardt in 1858, for the puerulus comes right out of the phyllosoma.

Larval Stage of Jaxea nocturna.†—E. L. Bouvier describes the *Lucifer*-like trachelifer stage of *Jaxea nocturna*, a rare Decapod, the natant stage of which is still to seek.

Male of Anthura gracilis.‡—E. W. Sexton gives a full description of the adult male of this Isopod. The female and young male have been previously described, but not the adult male. The statocysts on the telson are in general structure the same as those of *Cyathura* described by Thienemann. Each consists of an oval vesicle, with crystalline bodies forming a statolith, with a fine duct communicating with the exterior, and with a strong muscle attached to the anterior wall.

Annulata.

Studies on Polychæts.§—W. C. M'Intosh discusses additions to British Spionidæ and Cirratulidæ recorded by Southern from the West Coast of Ireland; the British Terebellidæ, describing twenty-five species; Terebellids collected by the 'Porcupine' and the 'Knight Errant'; Chætopteridæ, Amphictenidæ, and Ampharetidæ from the Gulf of St. Lawrence; Ampharetidæ and Terebellidæ from off Norway; and the occurrence (1863) of one of the Pisionidæ (*Macrochæta clavicornis* Sars) at St. Andrews. Numerous bristles and hooks are figured.

British Marine Annelids.‖—W. C. M'Intosh is to be congratulated on the progress of his monograph on British Polychæta, the present instalment being the first part of the third volume. It deals with the families Opheliidæ, Scalibregmidæ, Sphærodoridæ, Telethusæ, Chloræmidæ, Chætopteridæ, Spionidæ, Cirratulidæ, Capitellidæ, Maldanidæ, Ammocharidæ, which are represented by fifty-four genera.

Oligochæta from Northern India.¶—J. Stephenson describes a large number of new species mainly from Northern India. Noteworthy is *Enchytræus hararami* sp. n., for only one other certain species is known from India. The sperm-sacs are described. The occurrence of

* Journ. Marine Biol. Assoc., x. (1914) pp. 179–93 (6 figs.).
† Journ. Marine Biol. Assoc., x. (1914) pp. 194–206 (11 figs.).
‡ Journ. Marine Biol. Assoc., x. (1914) pp. 236–43 (12 figs.).
§ Ann. Nat. Hist., xv. (1915) pp. 1–58.
‖ Ray Soc. Monograph (1915) viii and 368 pp.
¶ Records Indian Museum, x. (1914) pp. 321–65 (1 pl.).

Microscolex phosphoreus at Peshawar, in the extreme north of India, 700 miles from the sea, is interesting since the species had its probable original home in the temperate zone of South America, whence, with other representatives of its genus, it has been drifted across the South Atlantic and Indian Oceans and become widely distributed in the Southern Hemisphere. Some of the other records are of much interest.

Leptonereis glauca Claparède.*—L. N. G. Ramsay describes this small Nereid from wharf piles at Plymouth. He revises the characters of the genus which agree with those of *Nereis*, except in the following respects. The proboscis is furnished only with soft papillæ: the notopodium and neuropodium are rather deeply divided; in the male heteronereid, the body is divided into three distinct regions, the middle one only being modified for swimming, while the posterior is marked by the appearance of peculiar fused setæ, not present in the Nereid-form or in the female heteronereid. The species of *Leptonereis* are discussed, and it is pointed out that *Leonnates pusillus* of Langerhans is at least vary closely related to *Leptonereis glauca* of Claparède.

Nematohelminthes.

Structure of Female Genital Apparatus in Spiruridæ.†—L. G. Seurat has made a comparative study of the female genital apparatus in this family of Nematodes. The simplest type is seen in *Protospirura numidica* of the cat. The large vulva, a little behind the middle of the body, is connected with a relatively short straight ovijector, which has no reservoir for storing the eggs. The uteri run in opposite directions, one towards the head and one towards the tail.

Spirura, remarkable for an attaching cutaneous fold in the region of the œsophagus, has female genital parts like those in *Protospirura*, from which it may be derived. Another branch leads to *Gongylonema*, living in a burrow in the mucous membrane. In this genus the uteri are divergent as before, but the vulva is near the anus. In *Gongylonema scutatum* Müller, the ovijector is almost half as long as the body (31 mm. in an individual of 70 mm. in total length) and in *Viguiera euryoptera* Rud. the ovijector is also very long.

In other Spiruridæ the vestibule and the sphincter are not in a straight line, e.g. in *Hartertia*; in *Habronema*, a central group, the vestibule may be straight and without a storing receptacle, as in *H. microstoma* Schn. of the horse, or with a pyriform reservoir capable of holding 200 eggs as in *H. muscæ*, also from the horse.

From *Habronema* two series diverge. In one the vulva approaches the anus; in the other it is shunted towards the head. In both, there tends to be a change in the position of the uteri, which come to lie side by side. The first series includes *Cyrnea* and *Tropidocerca*; the second series includes *Physocephalus*, *Arduenna*, *Spirocerca*. The author's general conclusion is that the condition of the female genital organs gives a clue to phylogenetic relationships.

* Journ. Marine Biol. Assoc., x. (1914) pp. 244–52 (1 pl.).
† Comptes Rendus, clix. (1914) pp. 1016–18.

Echinoderma.

Variability in Hybrid Echinoids.* — O. Koehler reared larvæ from ova of *Sphærechinus granularis*, fertilized by spermatozoa of *Strongylocentrotus lividus*, and observed the fluctuating variability of the characters. The question is whether this is an expression of environmentally induced modifications, or of diverse combination of Mendelian factors. His observations lead him to the conclusion that an important determinant of the direction of the inheritance (from similar as well as from dissimilar parents) is the relative age of the gametes at the time of fertilization.

The causes of the variability in the f_1 hybrids of the cross *Strongylocentrotus* ♂ and *Sphærechinus* ♀ are exclusively internal; they are to be found in the different ages of the gametes at the moment of fertilization, and in the occurrence of a periodic oscillation of the hereditary force of the gamete with increasing age. The potency changes with age. Whether the fluctuations are hereditary or not has not been determined.

Variability in Rays of Starfish.†—W. J. Crozier has collected data in reference to *Asterias tenuispina* at Bermuda. The modal number of rays is 7; the range in ray number is 2 to 9. The 7-ray condition is uniformly the most frequent, even in widely separated localities. The modal ray-number is the same for animals with subequal rays as for those with a group of regenerating rays.

The evidence indicates that, most commonly, this starfish has 7 rays before it undergoes autotomy, that it divides into 3-ray and 4-ray portions, and that each of these parts regenerates four rays. Regenerating rays tend to appear in bilaterally disposed pairs, as regards size. There is no evidence that self-division occurs often in the life of individuals, though possibly it does. New rays may be added at any point on the disk.

The number of madreporites varies from one to five, and is to some extent correlated with the number of rays. It is not correlated with the size of the animal. Double or triple madreporites occur in about 5 p.c. of the individuals.

Notes on Holothurians.‡—J. H. Orton makes a detailed contrast of the specific characters of *Cucumaria saxicola* and *C. normani*; the differential characters of most importance being found in the main body spicules, in the spicules near the surface of the body, in the shape and number of the gonadial tubes, and in the shape and relative stoutness of the pieces of the calcareous collar. The variation of the gonadial tubes in *C. saxicola* is recorded; the usual number is 24 or 25, but there is variation between 10 and 61, between 10 and 33 in females, between

* Ber. Nat. Ges. Freiburg, xx. (1914) pp. lxxv–xc (2 figs.).
† Amer. Naturalist, xlix. (1915) pp. 28–36 (13 figs.).
‡ Journ. Marine Biol. Assoc., x. (1914) pp. 211–35 (13 figs.).

15 and 61 in males. In *C. normani* the gonadial tubes vary from about 250 to more than 800, and the three males examined had more than the three females. The calcareous collars of the two species mentioned are carefully compared, as also the differences in the spicules of the tube-feet. The growth-stages of the bell-shaped spicules of *C. normani* are described.

It was found that in the species *normani*, *hyndmanni*, *elongata*, the gonad consists of numerous short cylindrical tubes, and the dorsal as well as ventral ambulacra have well-developed tube-feet. In the species *saxicola* and *brunnea*, the gonad consists of relatively few large club-shaped tubes, and the dorsal ambulacra contain mostly ambulatory papillæ (less numerous than the tube-feet in the ventral rows), but have a few definite tube-feet at the anterior ends. The species of this second group may have to be referred to the genus *Colochirus*. The author has also notes on *Cucumaria elongata* and *Thyone raphanus* from the Plymouth district.

Cœlentera.

Development of Plumularian Planula.*—Ernest Warren describes a Plumularian, provisionally called *Schizotricha simplex* sp. n., and the development of its planula. The hydroid, collected at the mouth of the St. John's River, Pondoland, shows the typical characters of the genus *Plumularia*, with the exception of the presence of downward directed offshoots from the pinnæ, and the somewhat unusual occurrence of the main stem bearing hydrothecæ. The pinnules are similar in every way to the pinnæ, and they originate from the pinnæ just as the latter do from the main stem. They bear a short basal internode with transverse nodes and no nematophore.

The development of the planula is noteworthy in that the egg never becomes charged with yolk. The ovum remains small and segments in the midst of a feeding or placental tissue. Ultimately the embryo grows into a well-developed planula, with dimensions very greatly exceeding those of the original egg. The placental tissue arises as a modification of a specialized portion of the ectoderm of the blastostyle. This portion forms a kind of cap over the young ovum, and may be regarded as representing the manubrial ectoderm of a rudimentary gonophore which bears one egg.

Remarkable Longitudinal Scissiparity in a Madrepore.†—Ch. J. Gravier describes in *Schizocyathus fissilis* Pourtalès a remarkable mode of asexual multiplication. The calyx is always inserted obliquely on a narrow base, triangular in cross section. There are three cycles of septa, and there is no columella. Six groups are formed, each consisting of a median septum of the first cycle and two lateral septa of the third cycle. Pourtalès interpreted the facts as due to intracalycinal budding. Lindström suggested that there was a dislocation into six groups, that

* Ann. Natal Museum, iii. (1914) pp. 83–102 (1 pl. and 4 figs.).
† Comptes Rendus, clx. (1915) pp. 103–5.

the polyp remained attached to one or more, and that it began to reconstruct a new calyx around itself.

One of Gravier's specimens showed six equal groups, separated for almost their entire length, united above by the living tissues. There was no trace of budding. It seems that when the coral reaches a certain size the wall is no longer strong enough to hold together the six segments. These and their living tissues fall apart, and on each of them a new calyx is formed. There is regeneration following longitudinal scissiparity—spontaneous division into six segments, and then a reconstruction on the part of each. This is the more remarkable when we note that the living tissues form but a thin layer on the surface of the strongly developed calcareous framework.

Nerve Conduction in Cassiopea.*—A. G. Mayer finds that the rate of nerve conduction increases as the concentration of the cations of sodium, magnesium, calcium, and potassium decreases. The sodium cation is an active stimulant for nerve-conduction. The magnesium cation is inert and non-toxic; its role in respect to sodium in sea-water is comparable to that of the nitrogen of the air in relation to oxygen. The effects of potassium are similar to those of sodium, but more marked. These generalizations apply also to the rate at which the motor centres or rhopalia generate stimuli which produce the nerve-impulse, but the rhopalia seem to be more readily affected by osmotic and by concentration changes than are the nerves.

In trochophores, ctenophores, and other forms with well-differentiated cilia which move in a co-ordinated manner, the normal muscular tonus of the animal produces a state of tension over the outer skin, thus pressing upon the cilia-bearing cells and reducing or even stopping their movement. When the tonus is relieved, however, the cilia beat rapidly. Thus magnesium reduces the muscular tonus and the cilia beat with abnormal activity. Sodium contracts the muscles and stops the cilia. Hence the converse relation between the neuro-muscular and the ciliary movement is a mechanical, not a chemical, matter.

Law Governing Loss of Weight in Starving Medusæ.†—A. G. Mayer has experimented with *Cassiopea xamachana*, a Scyphomedusa. When the animal starves the gelatinous mesoglœa decreases in volume and apparently serves as the chief store of food. If W be the weight of the medusa when starving begins, a W may represent the decline in weight due to loss of body-substance and of water at the end of the first day, so that at the end of the first day the weight of the medusa is $W - a W = W (1 - a)$. Similarly, at the end of the second day the weight is $W (1 - a) - a W (1 - a) = W (1 - a)^2$. Hence the weight y after starving x days is $y = W (1 - a)^x$ where a may be called the index of catabolism, the rate of starvation increasing as a increases.

The medusæ were kept in doubly filtered sea-water in diffuse day-

* Carnegie Inst. Washington Publications, No. 183 (1914) pp. 25–54 (13 figs.).

† Carnegie Inst. Washington Publications, No. 183 (1914) pp. 55–84 (1 pl. and 21 figs.).

light. It seems that the chemical constitution does not change, but that one and the same class of substances serves to maintain the animal. In Vertebrates the glycogen is first consumed and then the fats, but it is not so in the medusa where there is no appreciable selective use of different substances. The dried weight is about 4·76 p.c. of the living weight, and this ratio does not change as the animal starves.

In the starving animal the cells become reduced in size, many degenerate and disappear; the cell-boundaries tend to become indistinct. The gelatinous substance becomes vacuolated and the muscular tonus is largely lost. The bell-rim bends upward and inward in a balloon-like manner. The mouths on the mouth-arms disappear in about three weeks, so that even if there were nannoplankton present it could not be used.

Porifera.

Sponges of Lake Baikal.*—Nelson Annandale finds that some of the Baikal sponges are Haploscleridæ, namely the genus *Lubomirskia* Dybowski in the sub-family Chalininæ and *Baikulospongia* g.n. in the sub-family Renierinæ. The new genus includes forms like *Lubomirskia* in general structure, but friable (though hard) and not at all elastic. A stout basal membrane of a horny nature is present. The skeleton superficially resembles that of *Lubomirskia*, except that there is no horny sheath to the fibres, and that the vertical fibres do not form definite brush-like tufts at their distal extremity, but are more or less distinctly splayed out to form a horizontal skeletal reticulation. There are no true microscleres. Gemmules have been found in one species—ovoid or pear-shaped structures with a simple horny covering which is distinctly depressed in a crateriform manner at the narrower end. They lie in the stout basal membrane of the sponge with their long axis parallel to it. The embryos, which are often abundant in *Baikulospongia bacillifera*, resembles those of *Lubomirskia*, but the free-swimming larva is unknown.

There are also true Spongillidæ in Lake Baikal, remarkable for the abnormal character of their microscleres. There can be no doubt that the species of *Lubomirskia* are of marine origin. Indeed one of them, *L. baikalensis*, has actually been found in Behring's Straits. Although the affinities of *Baikalospongia* are doubtful, it seems probable that its species are derived from a marine stock.

New Sponges.†—F. Ferrer proposes a new family of Sigmatophora (Ectyonillidæ) including *Ectyonilla* g.n. (with protriænes, with anatriænes, with an axinellid type of skeleton, without microscleres), *Cantabrina* g.n. (without protriænes, with anatriænes, with an axinellid type of skeleton, without microscleres), and a number of known genera —*Raspailia* Nardo, *Dictyocylindrus* Bow., *Cyamon* Gray, and *Trikentrion* Ehlers.

* Records Indian Museum, x. (1914) pp. 137–48 (1 pl.).
† Boll. Soc. Espãnola, Hist Nat., xiv. (1914) pp. 451–5.

Protozoa.

Foraminifera from Portuguese East Africa.*—Edward Heron-Allen and Arthur Earland describe two very interesting new genera from the Kerimba Archipelago. In *Iridia diaphana* g. et sp. n., the test is adventitious, usually attached, occasionally more or less free, consisting of a single cavity lined with a chitinous and diaphanous membrane or pellicle. The animal commences its existence as a small hemispherical dome-shaped chamber, white or light grey in colour, attached to sand-grains or shell-fragments, and constructed of very fine particles of mud and sand cemented together into a rather friable test with a chitinous lining. This chitinous lining is usually continued as a "floor" to the dome-shaped chamber, but in the youngest stage the chitinous floor is perhaps not always present The early dome-stage has sometimes an aperture at the top or side of the dome, but quite as often no special aperture is visible. The test increases in size by the protrusion of the protoplasm in irregular masses, which proceed to secrete a covering investment of sand-grains, attached to the chitinous lining. With the growth of the organism the construction of the test becomes coarser and the colour darker. With each increase in the size of the test, the enclosing wall of the preceding stage is absorbed so as to leave an undivided cavity of variable shape. In rare cases the test spreads as a forking tube. The external shape and the internal cavity may be very irregular owing to the haphazard mode of growth.

It seems clear that *Iridia* is a very simple and primitive Rhizopod. In its sessile hemispherical form, its chitinous lining, and occasionally papillate processes, it shows affinities with *Thurammina* and *Webbina*, but the aberrant and loosely constructed adult test is more suggestive of *Astrorhiza*, and it is in the family Astrorhizidæ that the authors place it. Some of the large specimens are strongly suggestive of *Astrorhiza limicola*, but lack the produced arms characteristic of that species. The genus may be regarded as being to some extent isomorphous with *Nubecularia lucifuga* Defrance. It may be noted that stages in its life-history were previously referred by the authors, with reservations, to *Thurammina papillata* and *Webbina hemisphærica*. There is extraordinary diversity in size of the Kerimba specimens, from 0·25 mm. in diameter in the early stages to 1 mm. in the adult stages. But some gigantic forms were 8 mm. in greatest diameter.

The second new genus is *Nouria* with three new species, which seemed at first like *Reophax ampullacea* Brady. Closer examination showed, however, that the shells were not monothalamous as in *R. ampullacea*, but polythalamous and more or less in a spiral in a Polymorphine manner. Many of them are conspicuous in having relatively large and highly coloured mineral particles in their tests, as well as in being of large size and irregular contour. Among the Kerimba specimens of *Nouria polymorphoides*, there is considerable variety of forms, comparable mainly with *Polymorphina compressa* d'Orbigny, but also with

* Trans. Zool. Soc., xv. (1914) pp. 363–90 (3 pls.).

P. oblonga Williamson. In *Nouria harrisii* the test is entirely composed of sponge spicules arranged in a single layer with their axes arranged more or less parallel to the long axis of the test. The "skill"—or "purpose"—exhibited by this little organism in the building of its test reaches its most remarkable development in the construction of the aperture. The spicules designed to form the terminal portion of the shell are selected by the organism of such size and shape as to form a perfectly tapered neck with a circular aperture, round which the points of the spicules often form a regular fringe. There are sometimes projecting spicules pointing aborally, which may keep the shell erect in the surface layer of mud, with the aperture upwards. In the third species, *N. compressa*, the shell is also composed of sponge-spicules, but there are occasional sand-grains or mineral flakes.

The Kerimba material was collected by Dr. J. J. Simpson. It has yielded 460 different species and varieties, including many new forms besides *Iridia* and *Nouria*.

Conjugation in Amœba.*—R. E. Hedges describes and figures the process of conjugation in a small species of *Amœba*, which he took to be *A. limax*. The amœbæ could be seen very clearly on the slide, but they were so filled with bacteria that it was in most cases impossible to distinguish a nucleus. Two amœbæ came into contact on the slide, and after remaining quiet for about 20 seconds the distinct line of contact between the two individuals broke through for a portion of its length, and the protoplasm of one flowed into the protoplasm of the other. The opening grew larger as the protoplasm flowed through, and the flowing did not take more than three or four seconds to be completed. The union was complete and not partial or temporary, therefore the word copulation is used instead of conjugation. The two individuals were of nearly the same size, and the result of copulation was a slightly larger *Amœba*. The transference of protoplasm was seen to be complete, none being cast off in the process. Several pairs were observed, and in one case the resulting *Amœba* was kept under observation for 4 hours. After remaining still for a few minutes, it crawled slowly into a mass of bacteria and remained there, apparently feeding, for the rest of the time. During that period it was approached by another individual five separate times, but after touching the two separated at once. The changes of shape and the development of a "brown body" are described and figured.

African Species of Volvox.†—C. F. Rousselet has a note on the sexual stages of *Volvox africanus* and *V. rousseleti*, from German East Africa. These sexual stages were collected by A. W. Jakubski, of Lemberg; the vegetative colonies, previously described by G. S. West, were collected by Leiper near the northern shores of the Albert Nyanza and by Rousselet at Gwaai Station in Rhodesia.

* Zool. Anzeig., xliv. (1914) pp. 214–19 (5 figs.).
† Journ. Quekett Micr. Club, xii. (1914) pp. 393–4.

Trypanosoma brucei.*—Sir David Bruce, A. E. Hamerton, D. P. Watson and Lady Bruce have studied a Zululand strain (1913) of Trypanosome, and find that it is the same species as that discovered by Bruce in Zululand in 1894, reported on by Kanthack, Durham, and Blandford in 1898, and named *T. brucei* by Plimmer and Bradford in 1899. In its structural characters this trypanosome is absolutely identical with the one causing disease in man in Nyasaland, *T. rhodesiense* of Stephens and Fantham.

The authors go on† to show that the pathogenic action of *T. brucei*, Zululand strain (1913) on various animals is so similar, not only in regard to the symptoms during life, but also in the post-mortem appearances and rate of mortality to that of the trypanosome causing disease in man in Nyasaland, that it affords another proof that these two trypanosomes are identical.

A third study‡ dealing with the trypanosome causing disease in man in Nyasaland, has shown that this belongs to the same group as *T. gambiense*, the development taking place in the alimentary tract and salivary glands, not in the proboscis, of the fly. The percentage of flies which become infected is the same as in *T. gambiense*, 8 p.c. The percentage of flies which become infective is about 1 p.c. The length of time which elapses before a fly becomes infected varies from 14 to 31 days, average 23 days. The infective type of trypanosomes in the salivary glands—corresponding to the final stage of the cycle of development—is similar to the short stumpy form found in the blood of the vertebrate host.

In a fourth paper § the authors state their conclusion that *T. brucei*, Zululand, 1913, belongs to the same group as *T. gambiense* as regards its cycle of development in the tsetse fly. The trypanosome causing disease in man in Nyasaland also belongs to the same group. The cycle of development of the Nyasaland and Zululand trypanosomes in *Glossina morsitans* is so marvellously alike that it affords another reason for believing in the identity of these two trypanosomes.

Sarcocystis muris.‖—Rh. Erdmann discusses some disputed points concerning the life-history of this Sarcosporidian. There are two sharply separated stages. The first period extends from the feeding with adult Sarcosporidia to the first stage in the musculature. It lasts for 28 to 30 days, and it is passed in the walls of the food-canal, in the lymphatics, and in the fatty tissue of the host. The second period includes the differentiation of the unicellular parasites within Miescher's corpuscles which contain numerous adult Sarcosporidia. This period is passed in the musculature only.

Dicystid Gregarines of Polychætes.¶—M. Caullery and F. Mesnil discuss *Polyrhabdina spionis* (Kölliker) found in *Scolelepis fuliginosa* in

* Proc. Roy. Soc., Series B, lxxxvii. (1914) pp. 493–510 (3 pls.).
† Proc. Roy. Soc., Series B, lxxxvii. (1914) pp. 511–16.
‡ Proc. Roy. Soc., Series B, lxxxvii. (1914) pp. 516–25 (1 pl.).
§ Proc. Roy. Soc., Series B, lxxxvii. (1914) pp. 526–31 (1 pl.).
‖ Arch. Zool. Expér., liii. (1914) pp. 579–96 (2 pls.).
¶ C.R. Soc. Biol. Paris, lxxvii. (1914) pp. 516–20 (10 figs.).

the intestine. A sporozoite attacks an intestinal epithelial cell, penetrating to some distance; it enlarges, especially in its free part; it develops ramified fixing and absorbing amœboid processes. It remains for a long time fixed; but free forms with epimerites were also found. There are other species:—*Polyrhabdina polydoræ* in *Polydora ciliata*. *P. brasili* sp. n. in *Spio martinensis*, and *Polydora pygospionis* sp. n. in *Pygospio seticornis*.

BOTANY.

GENERAL,

Including the Anatomy and Physiology of Seed Plants.

Structure and Development.

Vegetative.

Dorsiventrality in Ficus.*—O. Trülzsch has studied the causes of dorsiventrality in the stems of *Ficus pumila* and other similar climbing plants. The author finds that the dorsiventrality of the wood and bast is especially noticeable in that part of the stem nearest to the support, and is the direct result of difference in illumination. There is no transmission of asymmetry to those parts of the stems not within the zone of the unequal illumination. A similar dorsiventrality is found in creeping stems and in stems forced to grow in a bent position. When stems are kept in a bent horizontal position and subjected to a strong unilateral illumination, i.e. when the curvature, the geotropic and the heliotropic factors all act in the same direction, the dorsiventrality is especially marked. When one or more than one factor acts in opposition to the heliotropic factor, the dorsiventrality represents the resultant of all the factors. The development of the sclerenchyma depends upon the relative dampness of the two surfaces of the climbing stem, the greater moisture of the lower surface preventing any considerable formation. In *Ficus pumila*, *F. scandens*, and *F. barbata*, the aerial roots become dorsiventral when exposed to similar conditions; the same result is also seen in climbing branches of *Hedera helix*, *Cissus antarctica*, and *Ampelopsis radicantissima*, and in the stems of *Ricinus communis*. The dense formations of aerial roots just below the nodes of *Ficus* are not to be regarded as the result of those conditions which produce dorsiventrality, but rather as dependent upon dryness and light, both of which inhibit root-formation on the dorsal surface and thus indirectly cause thicker growths on the ventral surface. Moreover rudimentary aerial roots attain full development in the moist, shaded condition of the ventral surface, but are modified into simple organs of attachment on the light, dry, upper surface. The unilateral formation of hairs on aerial roots is also due to relative conditions of light and moisture. The asymmetry of the leaves of *Ficus* is an inherent character, not dependent on external conditions, while the anisophylly of the stem is a paratonic character brought out under the influence of external conditions.

* Jahrb. wiss. Bot., liv. (1914) pp. 1-70 (28 figs.).

Reproductive.

Ovules and Seeds of Cercis.*—J. A. Harris contributes further observations on the relationship between the number of ovules formed and the number of seeds developing in *Cercis*. The author finds that the type, variability, and correlation of the number of ovules and seeds per pod differ in individuals and in different habitats, but there is no reason for concluding that trees from different habitats can be distinguished by their seeds. The correlation for the number of ovules formed and the number of seeds developed in each pod of an individual tree is always positive and of moderate to high intensity. "The rate of increase in number of seeds developing per pod remains the same as we pass from pods with the lowest to pods with the highest number of ovules." The correlation between the number of ovules in each pod and the number of mature seeds is negative and usually of very low magnitude. These results are based only upon mature pods of *Cercis canadensis* and must not be regarded as of general application except on the basis of further investigation.

CRYPTOGAMS.

Pteridophyta.

(By A. Gepp, M.A., F.L.S.)

Ophioglossum pendulum.†—L. C. Petry discusses the anatomy of *Ophioglossum pendulum*, which shows great variability in certain structures, such as the number of protoxylem strands (2 to 6) in the root, and in the leaf-trace (3 to 12), these differences being associated with the size of the organ concerned. Buds develop on the roots; and the connexion of their vascular structures varies greatly. In this rhizome is an ectophloic siphonostele perforated by gaps of three kinds—root, leaf, and incidental. Medullary strands consisting only of xylem occur in some specimens; and their occurrence is taken to support the stelar nature of the pith. The strands which make up the leaf-trace arise as a curved series which later form a circle; but those strands which belong to the edges of the curve later break off to supply the fertile spike; that is, the supply of the spike is marginal.

Position of Buds in Botrychium.‡—H. Woynar discusses the position of the buds in *Botrychium*, which he considers characteristic for each species, and which may therefore be used as a means of diagnosis. The buds are certainly not absolutely stable in their position, but pass slowly from one to another. The different arrange-

* Bull. Torrey Bot. Club, xli. (1914) pp. 533–49 (4 figs.).
† Bot. Gaz., lvii. (1914) pp. 169–92.
‡ Oesterr. Bot. Zeitschr., lxiv. (1914) pp. 101–7 (2 figs.). See also Bot. Centralbl., cxxvi. (1914) p. 307.

ments are described, and previous published accounts of them are corrected. Several abnormalities are also discussed. The species principally treated of are: *B. Lunaria*, *B. simplex*, *B. matricariæfolium*, *B. neglectum*, *B. lanceolatum*, *B. boreale*, *B. virginianum*. The author considers the "Formenkreis" of *B. simplex* as the natural phylogenetic starting-point. He considers the much divided fern-like forms to be off-shoots.

Branched Cells in Prothallium of Onoclea.*—Caroline A. Black gives an account of the branched cells in the prothallium of *Onoclea sensibilis*. These occur when the prothallium is badly nourished and grown in a feeble light. The following divergences from the normal may occur. 1. The apical cell may bend back at an acute angle with the axis. 2. An irregularly lobed apical cell may be produced. 3. A cell in the filament may throw out a branch without forming a cross wall at the base. 4. A branched filamentous prothallium may have the proliferations originating in one cell. 5. There may be an increase in the number of growing regions. These cases are all figured.

Water-glands in Equisetum.†—S. Nishida publishes his investigations concerning the excretion of water in liquid form in species of *Equisetum*: namely, *E. arvense*, *E. limosum*, *E. hyemale*, and *E. palustre*. The following anatomical points are of importance. The structure of the leaves is characteristic for the different species, and may be relied on for identification. The structure of the leaf-apex can be distinguished in the *arvense*, *hyemale*, and *limosum* types. The outer wall of the leaf-epidermis is covered with a layer rich in silicic acid; only the leaf-apex has an outer layer rich in pectin material. The colouring matter (brown to black) of the leaf-apex is contained in the cell-membrane, and may be extracted by warming in water. It is rich in tannin. The whole leaf-point functions as a hydathode, an actively working water-gland.

Distribution of Pilularia.‡—M. Y. Orr discusses the occurrence of *Pilularia globulifera* in Glamorgan. Three localities have been recorded for the plant. But it is extinct at two of them, mountain tarns, and is now found at only one station in the county—in a peaty moorland pool near Welsh St. Donats, at an altitude of 400 ft. Here it is very abundant. The author describes the physical geography of the pool, the character of the water, and the composition of the flora in and around the pool. He also discusses the distribution of the plant in Britain and on the Continent, bringing out the point that *Pilularia* is frequently associated with *Subularia aquatica*, *Lobelia Dortmanna*, and *Isoëtes lacustris*. But these three plants are absent from the pool at Welsh St. Donats, though found in two upland pools twenty miles off.

* Bull. Torrey Bot. Club, xli. (1914) pp. 617–20 (2 pls.).
† Tokyo Bot. Mag., xxvii. (1913) pp. 170–2. See also Bot. Centralbl., cxxvi. (1914) p. 560.
‡ Trans. and Proc. Bot. Soc. Edinburgh, xxvi. (1914) pp. 281–5 (1 pl.).

New Ferns from Yunnan.*—G. Brause describes new ferns collected by R. P. Maire in Yunnan. Among them are four species of *Cheilanthes*, which brings the number of Chinese species up to 25, of which 20 are endemic. *Adiantum venustum* Don is remarkable in China for its great variety of form. Eleven new species and one new variety are described.

Bryophyta.

(By A. Gepp.)

Protoplasmic Connexion in Mosses.†—A. Piskernik has investigated and tested the various methods hitherto employed for proving protoplasmic connexion in mosses, and considers certain modifications advisable. Besides the moss species in which connexions had already been found, principally by Kienitz-Gerloff, she proves their presence in 5 hepatics and 22 more mosses. In certain parts of the mosses they were found in great numbers, in *Plagiochila* about 1000 in one cell. Between sporophyte and gametophyte no protoplasmic connexions were found. The best reagents were either saturated solution of iodine; or sulphuric acid 25 per cent. with or without methyl-violet: or sulphuric acid 10–25 per cent, run under the cover-slip and then slightly warmed and the specimen examined at once.

Starch in Bryophytes.‡—H. Rancken publishes the result of his studies on the starch of Bryophytes. In an historical introduction he shows how previous authors have arrived at several different conclusions, not only with regard to the presence or absence of starch in certain species, but also as to the meaning of the diminished starch formation found in many species. The paper is divided into: 1. The distribution of the starch in moss plants. 2. Independence of the starch contents from a developmental stage and from outside influences. 3. The starch formation of the various bryophytes; this treats of no less than 275 species examined, of which 151 were tested by the author. Then follows an account of the author's methods and work, and a biliography. The different moss species vary greatly in their power of producing starch, and each species has its specific capability. They may be divided into three categories: 1. The amylophyll species form starch in the assimilative organs of the gametophyte, and store it also in most of the other tissues; some species very richly as *Pellia* and *Marchantia*, fairly richly as *Mnium* and *Kantia*, moderately as *Bartramia*, sparely as *Sphagnum* and many species of *Hypnum*. 2. In the saccharophyll species the glucose, which is formed during assimilation, is not condensed into starch in the assimilative tissues. On the other hand, in other organs starch or starch-like substances are stored in greater or less quantity (*Orthotrichum* or *Lophozia*). 3. A few species (*Andreæa petrophila*, *Hedwigia*

* Hedwigia, liv. (1913) pp. 199–209 (1 fig.).

† Oesterr. Bot. Zeitschr., lxiv. (1914) pp. 107–20 (2 pls.). See also Bot. Centralbl., cxxvi. (1914) p. 419.

‡ Acta Soc. pro Fauna et Flora Fennica, xxxix. No. 2 (Helsingfors, 1914) 101 pp. See also Bot. Centralbl., cxxvi. (1914) pp. 536–7.

albicans, Frullania dilatata, Radula complanata) are anamyl and form no starch, either in assimilative or storing tissues. Their product of assimilation is sugar, their reserve material principally fats.

In the anamyl and saccharophyll mosses the suppression of the starch formation may be regarded as an adaptation to xerophil conditions, which is especially found among the more lowly organized lithophytes and epiphytes. It is often associated with weakly developed conducting tissue. Starch is richly developed in bryophytes which inhabit moist situations, e.g. thalloid hepatics, Polytrichaceæ., Bryaceæ. Starch is more densely stored in the terminal bud and vaginula, in the sexual organs and sporogonium. And in such cases it takes the form of minute grains. Large grains occur mostly in the form of leucoplasts in the thallose liverworts.

New Antitrichia.*—J. Glowacki describes a new species of *Antitrichia, A. pristioides*, which he found in two localities in Montenegro at a height of 1000 m. It is a stonter plant than *A. curtipendula*, the growth is more upright, and the leaves are patent. The leaf-apex is toothed : there are no accessory veins. Fruiting specimens from Hodza near Sarajewo were of a deep brown colour, and the hexagonal cells of the capsule epidermis showed radial stripes of straight lines of thickened tissue on the outer capsule wall. The spores are almost twice as large as in *A. curtipendula*. The plant grows on stems of red beech and fir.

New Mosses from West Ross-shire.†—J. Stirton publishes descriptions of six new mosses from West Ross-shire—namely, *Campylopus Fergussoni, C. crenulatus, C. citrescens, Bryum rubicundum, Hypnum intortum*, and *Campylopus perplexans*—all collected near Plockton in 1913. By way of introduction he calls attention to certain large cells of moss leaves, which latterly have played an important part in the discrimination of species. 1. Large oblong cells usually with thickish walls, either pale or becoming more or less red or brown and then opaque, situated at the base of the leaf either next the margin—the usual situation of the auricles—or next the nerve, situated almost always in the centre of the leaf. 2. Elongato-hexagonal cells with thin walls, in double layers—that is, one layer of cells on the anterior surface, the other just behind the first (as shown by thin transverse sections of the lower part of the leaf). The position of these groups is either at the alar margin or at the middle base. 3. Another cell plays nearly as important a part as the other, although it is seldom or never seen quite at the base of a leaf, viz. the fusiform, either hyaline or filled with granules, or a modification of it (the more frequent), viz. undulating or sigmoid in place of straight throughout.

Moss Flora of Carinthia.‡—K. Prokaska records his investigations in the Lower Gailthal, and gives a list of the mosses and hepatics. No new species are described. In specimens of *Alicularia scalaris*, he found

* Oesterr. Bot. Zeitschr., lxiv. (1914) pp. 136–8 (1 fig.).
† Trans. and Proc. Bot. Soc. Edinburgh, xxvi. (1914) pp. 241–7.
‡ Jahresb. k.k. Staatsgym. Graz, 1913–14, pp. 3–15.

but seldom oil-bodies in the leaf-cells, which are, however, richer in chlorophyll. The author hopes to explore bryologically the regions round Hermagor, Passriach and Gortschach, which promise to yield a rich booty.

Post-glacial Mosses of Cracow.*—A. J. Zmuda gives an account of the fossil-flora of the Cracow diluvium, including seventy-two mosses, twenty-five of which are absent from the local flora of the present day. Six strata lying above Miocene clay were investigated. The two lowest strata are early post-Glacial and contain mosses of Arctic and Arctic-Carpathian types. The third stratum is post-Glacial, is remarkable for containing all the European species of *Calliergon*, and a Tundra-flora. The next two strata contain a forest-flora with mosses which are absent or rare near Cracow nowadays. The author describes his methods for extracting and preparing the fragments of mosses, etc., for the Microscope.

Bryophyta of the Near East.†—V. Schiffner writes on Bryophyta from Mesopotamia and Kurdistan, Syria, Rhodes, Mytilene, and Prinkipo, collected by Freiherr v. Handel-Mazzetti. The material from Mesopotamia shows a quite European character. Eighteen species occur in Middle and South Europe—ten are typical Mediterranean species, two are already known from Near Asia, while six species and four varieties, all new, belong distinctly to "Formenkreisen" of Europe. It is noteworthy that *Riccia Frostii* and *Tortula Fiorii* only occur there on soil containing gypsum. Many acrocarpous mosses form here a two-layered leaf-lamina (e.g., *Tortula desertorum*), or have a tendency to partial formation of a double layer of cells (*Barbula vinealis*, *Grimmia apocarpa*). This is probably caused by climatic conditions. The Kurdistan flora is also European, with the exception of one new quite foreign type, namely *Anoectangium Handelii*. It is thus evident that large tracts of Asia (the whole of Near Asia with Mesopotamia and Persia, all Siberia, and a great part of Central Asia) possess an almost purely European moss-flora. On the other hand the Atlantic coasts of Europe show, compared with the rest of Europe, many more strange elements. New species are described, and figures of their structure, and of neighbouring species, are compared. Interesting notes are given on synonymy, relationship, and distribution.

North American Mosses.—A. Le Roy Andrews ‡ publishes further notes on North American *Sphagnum*. He defines the character of the group *Cuspidata*—the outward position of the chlorophyll cells of the branch leaves; the pores of the hyaline cells commonly reduced to a minimum; the small distinctive stem-leaves; the shape of the branch-leaves: and the dioicous inflorescence. The North American species

* Bull. Internat. Akad. Sci. Cracovie, 1914, Sér. B, 2, pp. 209–352 (4 pls.). See also Bot. Centralbl., cxxvi. (1914) p. 669.

† Ann. k.k. Naturhist. Hofmuseums, xxvii. (Wien, 1913) pp. 472–504 (100 figs.). See also Bot. Centralbl., cxxvi. (1914) p. 628.

‡ Bryologist, xviii. (1915) pp. 1–6.

are *Sphagnum Lindbergii*, *S. riparium*, and *S. obtusum*. These are discussed critically and at some length.

A. J. Grout * publishes an illustrated note on *Leptobryum pyriforme* with gemmæ from a greenhouse in Miami University. It differs in habit and appearance from the normal fruiting plant.

E. J. Hill † discusses the little-known *Fontinalis Umbachii* Cardot, and gives a translation of the original description. He publishes notes on the type-locality and two other stations in Illinois where he has collected the species, adding critical notes on the peculiarities of the individual specimens.

Hepaticæ of Alaska.‡—A. W. Evans publishes a report on the hepaticæ of Alaska based on a large collection made in 1913 by the Kelp Investigation Expedition of the United States Bureau of Soils. Most of the specimens were collected by Prof. T. C. Frye, of the University of Washington. Seventy species are enumerated, twenty of which are new to Alaska, seven new to America, and three new to science. Thirty-five other species have been recorded, making the total flora 105 species. Evans gives a bibliography of the more important papers, and a map and a list of the localities visited by the Expedition. He describes the following new species — *Plagiochila alaskana*, *P. Fryei*, *Radula polyclada*, and discusses sundry other species critically. He discusses also the relationship of the flora to that of other regions.

Dicranaceæ of New Zealand.§—H. N. Dixon continues his studies in the Bryology of New Zealand by giving a critical account of the following genera of Dicranaceæ :—*Trematodon* (4 species) ; *Pleuridium* (5) ; *P. longirostre* is new and found in Otago ; *Ditrichum* (7) ; *Saelania* (1) : *Ceratodon* (1 species and a sub-species) ; *Cheilothela* (1 species) : *Distichium* (1) : *Pseudodistichium* (2) ; *Seligeria* (1) ; *Blindia* (3) ; *Dicranella* (5) ; *D. wairarapensis* is new and occurs in the North Island ; *Campylopodium* (2) ; *Dicranoweisia* (1). All the species recorded for New Zealand are carefully sifted, and according to their merits are accepted, corrected, reduced to synonyms, or rejected. The genera *Bruchia* and *Dichodontium* are rejected for lack of confirmatory evidence of their existence in New Zealand. Keys to the genera and species are provided.

Australasian Hepaticæ.‖—F. Stephani and W. W. Watts publish a list of "Hepaticæ Australes" collected in Australia and Lord Howe Island by the Rev. W. W. Watts, and in the New Hebrides by the Rev. Dr. Gunn and others. Descriptions of many new species are supplied by Stephani—forty-nine from Australia, twenty-seven from the New Hebrides, and six from Lord Howe Island.

* Bryologist, xviii. (1915) pp. 9–10 (1 fig.).
† Bryologist, xviii. (1915) pp. 10–12.
‡ Bull. Torrey Bot. Club, xli. (1914) pp. 577–616 (1 pl. and 3 figs.).
§ New Zealand Inst., Bull. No. 3, pt. 2 (Wellington, 1914) pp. 31–74 (2 pls.).
‖ Journ. and Proc. Roy. Soc. N.S.W., xlviii. (Sydney, 1914) pp. 94–135.

Bryological Notes.*—H. N. Dixon publishes a fourth chapter of Miscellanea Bryologica, giving critical remarks on: 1. Some Australasian species of *Breutelia*. Owing to the inconstancy of the structures alleged to be characteristic of the following species, *B. comosa* Mitt., *B. divaricata* Mitt., and *B. consimilis* Hook. f. et Wils.; these species must be reduced to synonyms of *B. pendula* Hook. Also *B. fusco-aurea* Broth. may prove to be synonymous with *B. Sieberi* Hornsch., a species very rare in New Zealand. 2. Two South African species of *Microthamnium*—*M. carifolium* and *M. cygnicollum* are described for the first time. Previously they were known only by name, and were stated to be one and the same species. 3. *Neckera Hoehnelii* and *N. Hoehneliana*, both East African mosses, described in the same paper, but in different sections of the genus. The second is a true *Neckera*; the first, a *Calyptothecium*, is the *Renauldia Hoehnelii* of Brotherus, and, as Dixon shows, has as synonyms *Trachyloma africanum* Rehm. and *Calyptothecium africanum* Mitt.

Thallophyta.

Algæ.

(By Mrs. E. S. Gepp.)

Morphological Obervations on Volvocaceæ.†—P. Desroche publishes some observations on the Volvocaceæ. In the genera of Volvocaceæ, which have two cilia, the red spot always appears on the apparent circumference of the individual and in the plane of the cilia. Double individuals are often seen in cultures, in conditions defined by the author. In them also the red spot lies in the plane of the cilia. Is this red spot an ocular point? Ehrenberg, and, more recently, Janet, admit the view. Possibly it is connected with the motor apparatus. The relation of the position between the cilia and the red spot is an argument in favour of this hypothesis. The author has made a special study of *Chlamydomonas de Baryana* Gorosch.

Reproduction of Peridinium Westii.‡—J. Virieux describes the reproduction of a limnetic *Peridinium*, *P. Westii* Lemm. The species, which is abundant in the Jura Lakes, shows a curious mode of sporulation. The multiplication takes place in summer; the protoplasm contracts and becomes isolated from the envelope, producing at the same time a quantity of mucilage. This swells up and forces asunder the parts of the valves. Cellular division has preceded this, resulting in 1–4 daughter-cells. In the superficial waters of the lakes, mucilaginous masses are found floating passively about for some time, and resembling

* Journ. Bot., liii. (1915) pp. 16–23.

† Assoc. Franç. pour l'avanc. Sci., Session de Tunis, 1913 (1914) pp. 307–12 (3 text figs.). See also Bot. Centralbl., cxxvi. (1914) p. 410.

‡ C.R. Séanc. Soc. Biol., lxxvi. (1914) pp. 534–6 (figs.). See also Bot. Centralbl., cxxxi. (1914) p. 154.

up to a certain point true cysts. The author has tried to cultivate them, but without success. It is probable that *P. Westii*, which disappears in winter, possesses like *P. aciculiferum* thick-walled cysts; but up to the present only these curious zoospores with a mucilaginous sheath have been found, which behave like floating cysts. This is probably the result of the exclusively planktonic life of *P. Westii*.

Alternation of Generation in Algæ.*—C. Janet writes on the sporophyto-gametophytic alternation of generations in Algæ. The subject is treated under the chapter headings: I. Holophyte; II. Orthophyte (1) algæ of which the orthophyte presents no sporophyto-gametophytic alternation of generations (*Eudorina*, *Volvox*, Diatomaceæ, *Fucus*); (2) algæ of which the orthophyte does present such alternation (tetraspores of polysiphonous Rhodophyceæ, *Spirogyra*); (3) *Ulothrix zonata*, an alga representing the ancestral form in which was established sporophyto-gametophytic alternation.

Saprophytic Algæ.†—S. Mendreka has studied the transformation of green algæ into saprophytes, by supplying them with their necessary carbon in the form of sugar or other organic substances. The species under observation were *Clorotheciuin saccharophilum*, *Chlorella protothecoides*, and especially *Chlorella variegata*. The methods and formulæ employed are described.

Flagellates Inhabiting Plankton Diatoms.‡—K. Rouppert describes and figures a new species of *Salpingoeca*, growing on *Chætoceros Zachariasi* in a backwater of the Weichsel near Ciechocinck in Poland. It is minute, quite globular, seldom slightly oval, 5–6μ in diameter, elongated above into a short, sharply truncate cylindrical neck, 3μ long and 2–3 broad. A protoplast of globular form completely fills the upper part of the envelope; the nucleus is in the front end. The author also describes his examination of *S. frequentissima* Lemm. which confirms the results of Bachmann and Lemmermann on structural details. The swarm-spores are described in detail and figured.

Ceratium hirundinella.§—E. Malinowski has confirmed the relation between the form of the nucleus and the form of the cell. Elongated individuals possess a globular nucleus or one more or less drawn out axially to the cell. On the other hand, the shorter individuals have a nucleus broader than long. The length of the horns stands also in close connexion with the breadth of the cells. These facts are set forth in tabular form and are also shown in figures of individual specimens of *C. hirundinella*.

* L'alternance sporophyto-gamétophytique de générations chez les algues. Limoges, 1914 (7 figs. in text). See also Bot. Centralbl., cxxvi. (1914) pp. 410–11.

† Bull. Soc. Bot. Genève, v. (1913) pp. 150–80.

‡ Kosmos, Lemberg, 1913, pp. 1608–15 (2 pls.). See also Bot. Centralbl., cxxvi. (1914) p. 411.

§ Kosmos, Lemberg, 1913, pp. 1329–43. See also Bot. Centralbl., cxxvi. (1914) p. 411.

Algæ and Peridinieæ from the Jura.*—J. Virieux adds to our knowledge of the algæ of the Jura region by a paper on the algæ and Peridinieæ of Franche-Comté. He records some interesting species and describes some novelties. Most of the species recorded are figured and accompanied by interesting critical notes. *Peridinium bipes* appears to be the commonest species of the genus in the Jura.

Flagellatæ of Charkow.†—D. Swirenko writes on the Flagellatæ of the town of Charkow. He records 75 species, of which 58 are Euglenaceæ. *Euglena* is represented by 19 species, of which one, *E. charkowensis*, is new. Five other new species are described and figured. All are plankton organisms.

Russian Phytoplankton.‡—L. von Reinhard describes the phytoplankton of a lake 15 kilometres south-east of Smijow. It is 1–1·5 m. deep, 5 km. long, 3 km. broad, and has neither in- nor outflow. Two samples were collected by Stradomsky, which the author examined. Among the algæ predominate *Gomphosphæria lacustris* Chod. var. *compacta* Lemm., *Oocystis lacustris* Chod., *Cyclotella Meneghiniana* Kütz., *Pandorina*, and *Gonium*. The plankton is of a tychoplanktonic character. The diatoms which characterize larger lakes are wanting, such as *Fragilaria crotonensis* Kitt., and *Synedra delicatissima* W. Sm. There are many brackish-water forms, such as *Gomphosphæria*, *Nodularia spumigena*, *Amphora paludosa*, *Nitzschia Brébissoni*. There is no limnoplankton. The floating flora of the lake consists mostly of halophil species, to which also the brackish-water species belong. A new *Cosmarium*, *C. Alexenkovi*, is described and figured.

Two New Species of Characium.—F. Filarzky § gives the Latin diagnoses and figures of two new species of *Characium* previously described by Hanko. They were found on the claws of a cray-fish in a swamp near Poprád by Hanko, and named *C. setosum* Fil. and *C. saccatum* Fil. The locality has since been destroyed by railway works.

A. Scherffel ‖ discusses these two species, and their similarity to *C. gracilipes* Lambert and *C. cylindricum* Lambert, both from North America. He shows that though similar they are not identical, and they form two similar parallel lines of descent, both consisting of epiphytic forms.

* Bull. Soc. Hist. Nat. Doubs, No. 27 (1912–13) 12 pp. (text-figs.). See also Bot. Centralbl., cxxvi. (1914) p. 154.

† Trav. Soc. Nat. Univ. Imp. Kharkow, xlvi. (1913) pp. 67–90 (3 pls.). See also Bot. Centralbl., cxxvi. (1914) p. 214.

‡ Trav. Soc. Nat. Univ. Imp. Kharkow, xlvi. (1913) pp. 97–114. See also Bot. Centralbl., cxxvi. (1914) p. 213.

§ Bot. Közlemények, xiii. (1914) pp. 9–11 (fig.).

‖ Bot. Kozlemények, xiii. (1914) pp. 12–17. See also Bot. Centralbl., cxxvi. (1914) p. 213.

Diatoms of Upper Austria.*—R. Handmann has examined with special regard to diatoms, the following waters. Some pools near Windegg and St. Peter in the district of Zizlau by Linz, an arm of the Danube in the water-meadows near Steyregg, rocks on the edge of the Danube near Aschach and Margarethen, Linz. The localities were often visited. From the tabular synopsis of the algæ of the Danube area round Linz it may be gathered that the author records eight times as many species as Schiedermayr. They belong to 35 genera. Only five of Schiedermayr's species were not found by the author. Five of the species, determined by Peragallo, are identical with those found by Héribaud or Peragallo in tertiary strata in Auvergne. These species are described in detail, since they are varieties. In all, 108 species recorded by Handmann from the Danube region have been found fossil in various strata in Auvergne.

Diatoms of New Brunswick and Prince Edward Island.†— L. W. Bailey refers to the scarcity of literature on Canadian diatoms, gives a sketch of the physical conditions that characterize the region in which his own collections were made, and presents in a classified list the forms which so far have been observed. He adds critical notes on the more important genera, and draws some general conclusions from the facts recorded, concerning: (1) the remarkable richness of the diatom flora about the New Brunswick coasts; (2) the remarkable commingling of fresh-water and salt-water species (owing to the great fluctuation of tides in the Bay of Fundy); (3) the character of the plankton; (4) the relations of the Diatoms to each other and to other forms of life; (5) contrasts between the Diatom flora of the Bay of Fundy and Gulf of St. Lawrence; (6) geographical distribution; (7) generic and specific distinctions. He is of opinion that far too many species have been founded upon trifling distinctions of length and striation. *Coscinodiscus Baileyana* Mackay is a new species.

Norwegian Protococcoideæ.‡—H. Printz publishes his investigations of the Protococcoideæ in the neighbourhood of Christiania. After a short account of the literature on the Norwegian species and the group, he gives a list of all the hitherto known species. He himself has added largely to the number by his collections in the region round Christiania, representing different geological formations. He shows the difference caused by the presence or absence of lime, and other constituents in the soil. The principal part of the work is devoted to the systematic treatment. Two new genera *Dispora* and *Bumilleriopsis* are defined, many new species and varieties are described and figured; and to very many records important critical notes are appended, which add largely to the value of the work.

* Jahresb. Mus. Francisco-Carolinum, lxxii. (Linz, 1914) pp. 107–48 (3 figs.). See also Bot. Centralbl., cxxvi. (1914) p. 647.
† Proc. Trans. Roy. Soc. Canada, ser. 3, vii. sect. 4 (Ottawa, 1914) pp. 57–76.
‡ Vidensk. Skrift. I. Math. Nat. Kl., 1913 (1914) 6, i–iv, 123 pp. (7 pls. and 2 text-figs.). See also Bot. Centralbl., cxxvi. (1914) p. 198.

Oolithic Perforating Algæ.* — L. Cayeux records the presence of perforating algæ in oolithic iron ore of primary and secondary epochs. None are found up to the present in Silurian strata, but they begin in the Devonian and flourish in the Lower Lias. The Toarcian, Callovian, Oxford, and Valanginian ores are abundantly supplied with them. These organisms show a very marked predilection for the shells of molluscs: they never invade the remains of Encrinites. The shells of Brachypods and the skeleton of Bryozoa do not constitute a favourable medium for their development. The author is of opinion that these algæ were numerous in all calcareous deposits more or less formed by mollusc shells, and that they were preserved in the ore owing to the ferrous oxide which fixed their outlines.

Sargasso Sea.† — O. Winge discusses the problems of the Sargasso Sea, of which he claims to define the limits. He considers also that the supply of *Sargassum* is not maintained by the detachment of shore plants, but that the floating plants are pelagic forms of certain littoral species. He records two species in the Sargasso Sea, *S. vulgare* and *S. bacciferum*.

Marine Algology.‡ — A. Mazza continues his studies of the morphology of marine algæ, and treats of types of structure in the following genera: — *Polyopes* (4 species); *Codiophyllum* (3); *Carpopeltis* (3); *Cryptonemia* (4).

Projection of Marine Algæ.§ — E. Chemin writes of an easy method of exhibiting to a class of pupils the habit and appearance of small algæ, by mounting them on a slide and projecting them on a screen by means of an optical lantern. Algæ with a thin thallus, such as *Porphyra*, *Rhodymenia*, *Nitophyllum*, etc., give excellent images in all respects. Thicker forms give but a silhouette. Quite fifty European Florideæ yield satisfactory projections.

Fungi.

(By A. Lorrain Smith, F.L.S.)

New Saprolegniaceæ.‖ — W. C. Coker has described two new fungi, *Achlya paradoxa* and *Pythiopsis Humphreyana*, after growing them in pure cultures and watching the stages of development. Discussing the question of the spores escaping from the sporangium, or remaining in it, he says: "In case of bacterial contamination or foulness from any

* Comptes Rendus, clviii. (1914) pp. 1539–41. See also Bot. Centralbl., cxxvi. (1914) p. 409.
† Bot. Tidsskr., xxxiii. (1913), pp. 269–271.
‡ La Nuova Notarisia, xxvi. (1915) pp. 1–42.
§ Union des Naturalistes, iv. 2 (1914) pp. 32–34.
‖ Mycologia, vi. (1914) pp. 285–301 (2 pls.).

cause, or where the parts are put in liquid nutrient media, there is a strong tendency for the spores to be retained in the sporangium, or, if discharged, for them to sprout at once without a second swimming stage." The author has compared a large number of species of various allied genera with reference to the escape of the spores. He finds in the species he has cultivated that the spores are discharged by internal pressure and not through their own motion.

Haustoria of Meliola and Asterina.*—G. Arnaud alludes to the work of Maire, who proved that the fungi of these genera were parasitic on leaves, and withdrew nourishment from the host by means of haustoria somewhat like those of the Erysiphaceæ. The haustoria are generally the terminal cells of the hyphopodia. They pierce the cuticle of the epidermis at the junction of two cells, and are at first intercellular. In *Meliola* the haustoria are generally simple; occasionally the surface bears small projections. In *Asterina* they form digitations which increase the amount of surface. The haustoria of *A. clavispora* are spherical with a clearly defined double wall; the lower part produces one or more filaments which pierce the cell and form here and there unilateral swellings. In another species, *A. anonicola*, a pseudo-parenchyma is formed which fills the cell. A comparison is made with other genera.

In a second paper,† Arnaud examines the haustoria in the genera *Balladyna*, *Lembosia*, and *Parodiopsis*. Those of *Balladyna*, which resemble *Asterina* in being branched, traverse the cuticle of the epidermis and occupy the walls of the host-cells, they thus form "digitations" which are the haustoria, and which push inwards the internal layer of the cell-wall. The haustoria of *Lembosia* are more varied and follow various types, mostly they are branched filaments. *Parodiopsis* has a superficial mycelium and perithecia. The mycelium forms one or two large filaments which enter the host by the stomata and ramify, forming intercellular hyphæ which bear haustoria.

Aleuria and Aleurina.‡—F. J. Seaver gives an account of the American species of these genera of Discomycetes. They are both distinguished by the reticulate character of the spores, but those of *Aleura* are colourless, while those of *Aleurina* are coloured. The best known species of *Aleuria* is the brightly coloured *A. aurantia*. That and the three other American species are of an orange-yellow colour, and are all of them European as well as American. Two species of the new genus *Aleurina* are described; one of them a new species, being found as yet in America only.

Thelephoraceæ of North America.§—E. A. Burt continues his work on this family of Fungi. The present paper mainly deals with the genus *Cyphella*, but it also includes the description of a rare species

* Comptes Rendus, clix. (1914) pp. 807–9.
† Comptes Rendus, clix. (1915) pp. 180–3.
‡ Mycologia, vi. (1914) pp. 273–8 (3 pls.).
§ Ann. Miss. Bot. Gard., i. (1914) pp. 357–82 (1 pl.).

of *Craterellus* from Labrador named by the writer *C. borealis*. It is a small species of cream-buff colour, and grows among moss.

Under *Cyphella* he describes 21 species, some of them well known in Europe, but a number of them confined to America and new to science. Most of them are minute species; those newly described are figured. They range in diameter from a fraction of a millimetre for the smaller, to 5 to 15 mm. for the larger species. They grow mostly on dead twigs or herbage, and can only be distinguished from *Pezizæ* by microscopic examination.

Parasitism of Hymenochæte agglutinans.*—This fungus is common in the Eastern United States, where it is indigenous. It grows normally on alder trees, and often surrounds twigs or branches, cementing two or more together. A. H. Graves describes an instance in which a part of a large spice bush *Benzoni æstivale* was firmly bound to a dead alder stem by the fungus, and was killed. Death was due more to strangling than to parasitism, though after the stem is weakened the fungus begins to prey on the tissues.

Enumeration of Philippine Basidiomycetes.†—G. Bresadola and H. Sydow gives a list of larger fungi from these islands, mostly Polyporei or allied families. It is rather remarkable that the large bulk of the collections should be known plants. Only two are recorded as new species; *Hymenochæte subferruginea* and *H. deflectens*. In most cases the name of the province and the collector are given with the date of collection.

New or Rare Spanish Fungi.‡—R. G. Fragoso publishes a contribution of microfungi to the Spanish Flora. He has found *Uromyces Rumicis* on *Rumex Acetosella*, and suggests that the æcidia may be found on *Ficaria*. Other species of Uredineæ are accompanied by descriptive notes. There is a new species of Sphæropsideæ, *Phomopsis Paui*, found on dead stems and branches of *Xanthius spinosus*. The author considers that it may be the imperfect form of *Diaporthe Xanthii* which grows on the same host-plant. Of the 24 species listed, 20 are new for Spain.

Plant Diseases.—E. S. Salmon § publishes certain biological observations on the American gooseberry mildew. He suggests that only the perithecia that are formed in summer attain maturity: those formed later do not hibernate, as they never mature. Spring infection would be from those earlier formed, which pass the winter on the ground or on the branches.

A. S. Bondartseff ‖ has found a new *Botrytis* attacking the flowers of

* Mycologia, vi. (1914) pp. 279–84 (1 pl.).
† Philippine Journ. Sci., ix. (1914) pp. 345–52.
‡ Bol. Hist. Nat., xiv. (1914) pp. 429–37.
§ Ann. Applied Biol., i. (1914) pp. 177–82.
‖ Journ. Plant Diseases (Russian) viii. (1914) pp. 1–25 (4 pls. and 3 figs.). See also Bull. Agric. Intell. Rome, v. (1914) pp. 1367–8.

red clover (*Trifolium pratense*), which he describes as *Botrytis anthophyla*. The mycelium of the fungus permeates the plant and spreads by means of the seed. It does not seem to damage the vegetative part of the plant, but the anthers are damaged, and there is a loss of germinative power. The seeds harvested from diseased plants are smaller, but the percentage of germination is high.

A. S. Horne * has written a critical review of the principal potato diseases in Great Britain. They are caused by *Synchytrium endobioticum*, wart disease, *Phytophthora infestans*, the potato blight, and a *Fusarium* disease or dry rot caused by *F. Solani*: lastly, canker or powdery scab due to *Spongospora Solani*. All these are of considerable importance, and the methods of treating them are dealt with.

Celery leaf-spot disease † is due to the fungus *Septoria Petroselini* var. *Apii*. It is carried by the seed, so that the seedling is already infected when it appears above ground. The disease does not pass to other plants but is always propagated by the use of infected seed from diseased plants.

L. Ravaz ‡ states that the Black Rot of grapes caused by the fungus *Guignardia Bidwellii* has appeared in Spain, in the province of Valentia, where the grapes were almost entirely destroyed by the disease. Hitherto the disease has only been reported in France.

H. E. Morris § has studied and observed apple scab in the State of Montana for several years. It is a common disease wherever apples are grown, and is caused by *Venturia inæqualis*, the conidial stage of which is *Fusicladium dendriticum*. Morris found the fungus on twigs as well as on the fruits: and he considers it to be distinct from the pear scab, *Venturia pirina*. He has observed scab abundant on apple trees while pear trees growing beside them were unattacked. Some apple trees are more resistant than others to the disease, and the writer recommends the growing of these and also spraying with lime-sulphur or with Bordeaux mixture.

Vermoesen ‖ has given an account of the fungus diseases of *Hevea* in the Belgian Congo. Only one case of root disease due to *Fomes semitostus* was found. This was due to the well-drained character of the plantations and to the absence of dead stumps. A disease of branches and trunks called the die-back disease was wide-spread. The disease appears at the tips of the branches and works its way back towards the base of the stem. The fungus is probably *Diplodia cacaoicola*, which attacks *Hevea*, *Cacao*, etc., in various tropical countries.

The same writer ¶ publishes another paper dealing with the disease of *Cacao* in the same country. Root diseases were almost unknown. The chief trouble noted was due to the presence of *Diplodia cacaoicola*, which

* Ann. Applied Biol. (1914) pp. 183–203 (8 figs.).

† Ann. Applied Biol. (1914) pp. 204–6.

‡ Le Progrès Agric. Vitic., xxxi. (1914) pp. 114–15. See also Bull. Agric. Intell. Rome, v. (1914) p. 1369.

§ Bull. Mont. Agric. Exp. Stat., No. 96 (1914) pp. 69–102 (1 pl. and 3 figs.). See also Bull. Agric. Intell. Rome, v. (1914) pp. 1369–70.

‖ Bull. Agric. Cong. Belg., v. (1914) pp. 312–21. See also Bull. Agric. Intell. Rome, v. (1914) pp. 1522.

¶ Bull. Agric. Cong. Belg., v. (1914) pp. 182–202 (figs.).

destroyed some of the trees. Vermoesen recommends the cutting down and destroying of diseased trees as soon as observed, and the clearing up of all rubbish, by burning or by burying with lime. Several diseases of the fruits were determined as caused by *Phytophthora Faberi*, *Diplodia cacaoicola*, and by a *Colletotrichum* sp.

J. R. Weir * has described two new Polyporaceæ that destroy trees, *Fomes putearius* and *Trametes setosus*. The former is closely allied to *Fomes conchatus*, but it always occurs on coniferous wood, *Pinus ponderosa*, *Pseudotsuga taxifolia*, etc., with a preference for larch. The rot produced is similar to that caused by *Trametes Pini*, but the reduction of lignin is on a much greater scale. The disease is abundant in the northwest of Idaho in the white pine zone.

The second fungus, *Trametes setosus*, is chiefly parasitic on *Pinus monticola*, though occasionally on other Conifers. It was found in the same territory as *Fomes putearius* and causes serious damage to fallen merchantable timber in forest-fire areas. It reduces the lignin principally in the spring wood, thus causing the annual rings to split.

Mycorhiza of Calluna.† — M. Cheveley Rayner has published a paper on the obligate symbiosis of *Calluna* with the root fungus. She traces the historical knowledge of the *Mycorhiza* condition, and then deals with the fungi that are the symbionts of the roots of higher plants. The subject is attacked from various points. More especially she " confirms and extends the conclusions already reached with respect to the inability of *Calluna* seedlings to form roots unless infected at an early stage," etc. It was proved by cultures that seedlings wholly free from infection and grown in a variety of sterile cultures made little advance in growth, and the supply of nitrogen to the plant did not suffice to replace the fungus. It was observed that in normal plants the fungus appeared first as delicate outgrowths from the cells of the seed-coat. The degree of infection apparent in seeds when examined is variable. It was further determined that seed infection takes place not from the air but from the root upwards; all parts of the plant being permeated more or less with the mycelium of the fungus.

A fungus was successfully isolated from the ovary, and successfully cultivated, inoculation of seedling cultures proving that the Mycorhiza fungus had been secured. The morphological characters of the fungus are described and identified as belonging to the genus *Phoma*.

Other species of Ericaceæ were examined, including representatives of Rhododendroideæ, Arbutoideæ, and Vaccinioideæ, and the author has demonstrated the presence of the mycelium in the unopened flowers. In some of these plants the fungus has been found in the leaves, as in *Calluna*. A new sub-genus, *Phyllophoma*, has been proposed for the fungus.

* Journ. Agric. Res., ii. (1914) pp. 163–7. See also Bull. Agric. Intell. Rome, v. (1914) p. 1526 (2 pls.).

† Ann. Bot., xxix. (1915) pp. 97–133 (1 pl. and figs.).

Schizophyta.

Schizomycetes.

Bacteriotoxic Action of Water.*—R. Greig-Smith has conducted a series of experiments with regard to the bacteriotoxic action of water on *Bacillus prodigiosus* and *B. typhosus*, and has come to the conclusion that ordinary tap-water contains substances of the nature of bacteriotoxins, the toxicity of which is increased by boiling. It is suggested that these toxins are of similar nature to those demonstrated in soils, from which they may be extracted by rain and thus find their way into natural water supplies. The following protocol to one of his experiments shows the order of reaction that he has obtained :—

Date	Temperature of Water	Strain	1000 Cells *Bacillus typhi* became		
			Unboiled	Boiled	
				15 min.	60 min.
November 5, 1913	20° C.	976	460	2	0
,, 11 ,, ...	20° C.	L.I.P.M.	452	11	6
June 2, 1914	14° C.	L.I.P.M.	557	2	0

In order to exclude the possibility of the reduction of numbers being due to the transference of the bacilli from a saline to a non-saline medium, the bacteria were grown in sodium-chloride-free nutrient agar for several generations, and the experiment repeated. A similar reduction in the number of the bacteria was observed, thus showing that the reason for the destruction of the organisms is not to be found in the lessened salt content of the media.

Destruction of Paraffin by Bacillus prodigiosus and Soil-organisms.†—R. Greig-Smith has demonstrated the fact that *B. prodigiosus* and soil-organisms generally, are capable of utilizing hydro-carbons. His first experiments were conducted by saturating sifted dried blood with paraffin, removing the excess of paraffin, and mixing thoroughly; portions being then incorporated with sand and moistened with a suspension of *B. prodigiosus*. After fermentation for ten days, the loss of paraffin, as determined by extraction, was about 5 p.c. In another series of experiments in which casein and kieselguhr were used instead of blood and sand, the loss of paraffin ranged from 10 to 22 p.c. The bulky nitrogenous matter was then dispensed with. Kieselguhr was treated with paraffin, ground and sifted, mixed with sand and calcium carbonate, and sterilized. A synthetic medium containing peptone or asparagin was then added, and the medium inoculated with 2 c.cm. of a suspension of *B. prodigiosus* or soil-organisms. After incubation for a month at 28° C., the loss of paraffin occasioned by *B. prodigiosus* was 14 p.c., and 49 p.c. by the soil-organisms.

* Proc. Linn. Soc., New South Wales, iii. (1914) pp. 533-7.
† Proc. Linn. Soc., New South Wales, iii. (1914) pp. 538–41.

Proteus vulgaris.*—A. Berthelot has examined a large series of strains of *Proteus vulgaris*, obtained from cases of infantile diarrhœa, chronic intestinal inflammation, putrid meat, etc., for the purpose of clearing up several disputed points with regard to the differential characteristics of the organism.

With regard to the question of gram-staining, he is of opinion that, provided the test is carried out strictly by the method of Gram-Nicolle, a negative result is invariably obtained. In reviewing the question of the action of the organism on carbohydrates, he has ascertained that all races of *Proteus vulgaris*, whatever their origin, at the end of ten days at 37° C. produce acid in media containing glucose, galactose and saccharose, while those containing lactose or mannite are left neutral or take on an alkaline reaction. Under all conditions of growth *Proteus vulgaris* produces phenol. With regard to the disputed question of indole production, which is complicated so much by a consideration of the reagents employed and of the chemical composition of the medium in which the organism is grown, after a series of very careful experiments in which the greatest care was taken to exclude all fallacies, the conclusion is arrived at that not only does the indole reaction of this organism vary as between different strains, but that different results may be obtained even with cultures from the same race. It thus appears that the absence of indole in cultures of this organism cannot be used as a basis for differentiation from allied organisms.

Contribution to the Study of the Gonococcus.†—P. Forgeot, working in the laboratories of M. Morax, has isolated an atypical Gonococcus from a case of gonorrhœal ophthalmia, which possesses the faculty of fermenting maltose, galactose and dulcite, as well as dextrose.

In its capacity to ferment maltose it thus resembles the meningococcus, but, however, when tested against a meningococcus serum it completely fails to agglutinate.

When inoculated into guinea-pigs, the post-mortem appearances presented were typical of gonococcus infection.

Bacteriology of Gas Gangrene.‡—A. Santory and L. Spillmann, from observations conducted at the Military Hospital at Nancy on wounded French and German soldiers, are in a position to confirm the statements of Weinberg, Doyen, and Yamanouchi as to the finding of *Bacillus perfringens* (*Bacillus Welchii*) in the pus from gangrenous wounds, and of the important rôle that this organism plays in the etiology of gas gangrene occurring in actual warfare.

On four occasions they also isolated a lanceolate diplococcus, the biological properties of which are at present under investigation.

Classification of Bacillus Welchii.§—J. P. Simonds has investigated numerous strains of bacteria belonging to the *Bacillus Welchii* group, and is of opinion that the fermentation reactions in and the

* Ann. Inst. Pasteur, xxviii. (1914) pp. 839–65.
† Ann. Inst. Pasteur, xxviii. (1914) pp. 879–84.
‡ Comptes Rendus, clx. (1915) pp. 210–11.
§ Journ. Infect. Diseases, xvi. (1915) pp. 31–4.

ability or inability to form spores in glycerin and inulin broth appear to furnish a dependable method of dividing these bacteria into four sub-groups. The source of a culture is no indication of the sub-group to which it may belong. The strain of organism found in cow fæces belongs to quite a different group to those isolated from human diarrhœal stools, and in view of this it is suggested that the human gas bacillus carrier may prove to be of greater importance in the spread of infection than milk infected with the organism from bovine sources. The majority of those strains isolated from the stools of patients suffering from pernicious anæmia belonged to the same sub-group.

Bacteriology of Leprosy.*—J. A. Johnston has inoculated a series of rabbits and guinea-pigs with a strictly non-acid-fast *Streptothrix* which he had previously isolated from the liver of a patient who had died of typical leprosy. One of the pigs developed a pussy ocular discharge eight days after inoculation, smears from which showed enormous numbers of acid-fast bacilli. The animal died after nine months, and the liver, lungs, spleen, and some of the lymphatic glands showed marked nodular involvement and the presence of acid-fast bacilli in smears. This result is in accord with observations made previously by Bayon and Kedrowski respectively, and the author is of opinion that *Bacillus lepræ* is but the acid-fast stage of a remarkably pleomorphic *Streptothrix*.

Significance of the Actinomycetes in Nature.†—This communication by A. Krainsky may be practically considered as a monograph on the Actinomyces, giving as it does full details of the methods of collection and separation of species, morphology, physiology, and systematic identification of the varied members of this group of organisms. Many species readily produce pigment (rose, grey, yellow, black, etc.), and this capacity to form pigment appears to depend greatly on the nature of the culture medium. As a basis for classification the group may be divided into two sub-groups—Group 1, the macro-actinomycetes; Group 2, the micro-actinomycetes. With regard to the macro-actinomycetes, the colonies are large (usually 3 to 5 mm.), and are either coloured or colourless. On suitable media the aerial hyphæ are usually coloured. The colonies in glucose solution are typically colourless, the solution itself being sometimes coloured. With the second group, the micro-actinomycetes, the colonies are small (less than 3 mm.), with both the colonies themselves and the aerial hyphæ pigmented. In glucose solution the colonies are commonly coloured, but the solution itself is unstained. In contradistinction to the first group, the second group organisms strongly attack cellulose.

An excellent chromo-lithograph is appended, showing colonies of various species in different stages of growth.

Scarlet Fever in the Monkey.‡—W. Mair, working with various species of *Macacus*, has obtained very interesting results from the

* Philippine Journ. Sci., ix. (1914) pp. 227–30.
† Centralbl. Bakt., 2te Abt., xli. (1914) pp. 649–88.
‡ Journ. Path. and Bact., xix. (1915) pp. 441–55.

inoculation of washings from the mouths of scarlet fever patients and from cultures obtained from these washings. That the condition induced in the monkey was most probably that of scarlet fever is borne out by the appearance of Döhle's bodies in the blood of the infected animals. These bodies, which are not parasitic in nature, are constantly met with in the blood of scarlet fever patients, and cannot be experimentally produced by the injection of Staphylococci, Streptococci, *B. proteus*, tuberculin, thallianin, and so forth. The organism isolated from the monkey, and which is believed to be the specific organism, or one of the specific organisms, of scarlet fever, only grows on serum-containing media and not on ordinary agar or broth. In its morphology and staining reactions it closely resembles the pneumococcus, but does not show capsules, either in the tissues of the monkey or in the heart's blood of the mouse. The colonies, which at first resemble those of Streptococci, soon become quite distinctive, and may be recognized as being perfectly circular and presenting a ringed marking with a slightly denser centre, but they may have a uniform crinkled surface and, occasionally, a crenated margin. Sometimes the margin is distinctly raised, and in this case the centre becomes thinner than it was originally. The greenish colonies on blood agar plates also resemble the pneumococcus. Milk is rendered acid and is sometimes coagulated. The organism also produces acid in lactose, cane sugar, glucose, maltose, raffinose, and inulin. Mannite is slowly attacked, while dulcite and adonite are not changed. The diplococcus is pathogenic to mice on subcutaneous inoculation.

Torula marina.*—H. Coupin found in a Portuguese oyster a yeast which, grown on gelatin, formed circular whitish colonies, about 1 mm. in diameter. Sown in pepton-sea-water, a white powdery deposit was thrown down. There was no turbidity of the medium nor any surface scum. The deposit consisted of round yeast-cells, mostly 2 to 3 μ in diameter. There was much budding, but no spores.

The *Torula* grew well in sea-water to which glucose, gelatin, or agar was added. In saccharated media no gas is formed, but slight fermentation occurs slowly with some sugars.

The author thinks the organism, though adapted to salt-water, has a sweet-water origin. It is easily cultivated in media made with sweet-water, and it grows luxuriantly on carrot and potato.

Nitroso-Bacteria.†—H. S. Fremlin states that the nitroso-bacterium grows readily in or on ammonia agar, especially if 5 or 10 p.c. of beef broth be added. Potassium-phosphate agar containing bouillon-gelatin, but not ammonia, also leads to the formation, first of ammonia, and then of nitrite. Urine is also a good culture medium; so, too, are pepton-water, pepton-beef-broth, and milk or blood serum. The nitroso-bacterium is a powerful nitrite-forming organism. It is not readily destroyed, and a certain amount of organic matter is essential to its better development.

* Comptes Rendus, clx. (1915) pp. 251–2.

† Journ. Hygiene, xiv. (1914) pp. 149–62, through Journ. Chem. Soc., cvii. and cviii. (1915) 1, p. 46.

Potato and Friedlaender's Bacillus.*—G. Dannézon concludes from his observations that a vegetable substratum may in certain cases play an important part in the dissemination of pathogenic bacteria in nature, and particularly in water. From the tubers of the potato the pneumo-bacillus of Friedlaender was isolated. The organism was also found in well-waters.

* Comptes Rendus, clx. (1915) pp. 285–6.

MICROSCOPY.

A. Instruments, Accessories, etc.*

(1) Stands.

Swift's Sideros Metallurgical Microscope.† — This instrument (fig. 16), which was built according to the suggestion of J. E. Stead, F.R.S., is well suited for use in the laboratories attached to steel and iron works. The stage, which measures 4 in. by $3\frac{3}{4}$ in., is focused by means of a rack-and-pinion. In order to allow of the use of very low powers, such as a 4-in. objective, additional coarse focusing is obtained by sliding the optical tube in its cloth-lined fitting, and this fitting is provided with a clamp-screw so that no movement shall take place after having been set. There is also a fine-adjustment capable of focusing the highest power immersion objectives.

This stand is well adapted for use with the Swift attachable Cone Camera, and has at the upper end of the optical tube a fitting to carry it.

Nelson, E. M.—**Binocular Microscopes.**

[The author gives a very interesting review of the types and principles of the best known instruments.]

Journ. Quekett Micr. Club, xii. (Nov. 1914) pp. 369–80.

(2) Eye-pieces and Objectives.

Zeiss' New Object-glass, and a New Method of Illumination.‡ E. M. Nelson describes this short-tube oil-immersion auxiliary, which is made upon an entirely new plan, being nickelled all over, with the front lens set in a push-tube, and not screwed up as usual. It is a $\frac{1}{7}$th of 0·9 N.A. In the performance of this lens the corrections are very perfect. Although no fluorite is used in its construction it is very nearly apochromatic, and shows a considerable advance over semi-apochromatism, for only a slight trace of outstanding blue can be seen. Its defining power is quite remarkable, surpassing all object-glasses of similar aperture known to the author. On a Möller's probe-platte of sixty diatoms all are resolved except the two specimens of *Amphipleura pellucida*. The lens is sufficiently powerful to do all that is wanted in practical study, and, owing to its great working distance, it does not pick up by capillary attraction an unfixed cover-glass.

The lens is peculiarly suitable for the author's new method of resolving diatoms, for which he gives the following directions:—1. Place the diatom so that the striæ to be resolved are vertical in the field. 2. Set

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† James Swift and Son's Catalogue, 1914, pp. 36–7.

‡ Journ. Quekett Micr. Club, xii. (Nov. 1914) pp. 363–6.

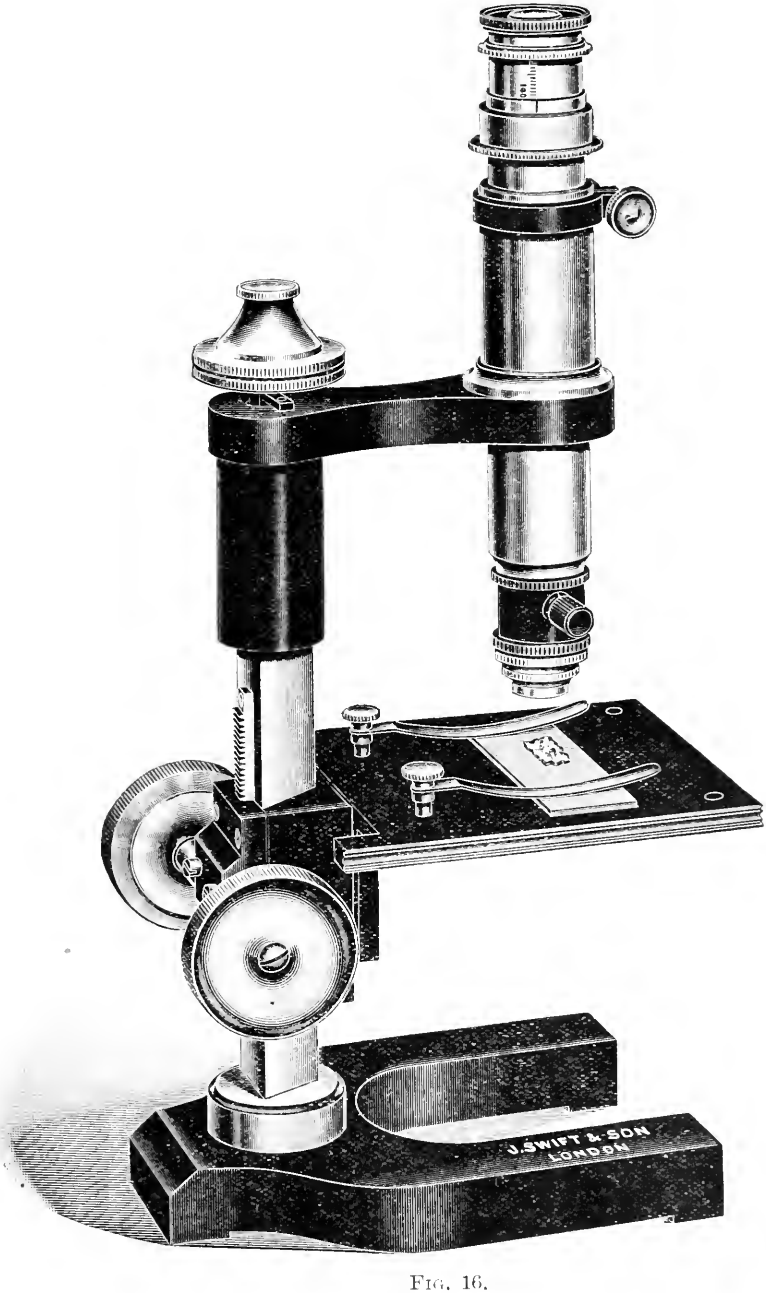

FIG. 16.

up a critical image with the edge of the flame in focus and central to the field, and open the diaphragm to its full extent. 3. By means of the substage centring screws move the condenser so that the image of the flame lies just outside the field of a high-power eye-piece. If the striæ are within the grip of the object-glass they will be resolved. This kind of illumination will be of service, for it will enable an observer to obtain high resolution, with a dry condenser, in an instant, without the troublesome manipulations usually necessary.

(3) Illuminating and other Apparatus.

Hutchinson Co-ordinate Micrometer.*—This instrument (fig. 17), made by J. Swift and Son, is a modified form of the ordinary ocular used with petrological Microscopes. In place of the cross-wires usually fitted, is mounted a glass plate, on which two systems of lines are ruled at right angles. In the illustration only the centre of the micrometer is

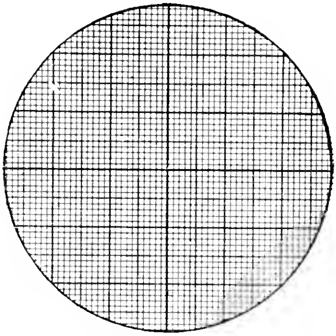

Fig. 17.

shown. These lines are 0·1 mm. apart, every fifth line being slightly thicker than the others, and every tenth line stronger still, while the two which intersect at right angles in the centre, and which correspond with the cross-wires, are given particular prominence. As the image of the object is projected on the network of lines, the ocular will be found useful for recording observations, as an enlarged drawing of any object can be readily sketched on paper similarly ruled, and its dimensions can be ascertained. By its aid the relative proportions of the various constituents of a rock can be estimated, and it is useful for recording the position of emergence of optic axes, and for finding the magnitude of the optic axial angle in bi-axial crystals. It may also be applied to the determination of this constant by Becke's method (measurement of the position and shape of the black hyberbolic brushes seen in convergent light), being an efficient substitute both for the revolving table used by Becke, and for the double-screw micrometer recommended by F. E. Wright.†

* James Swift and Son's Catalogue, 1914, p. 20.
† Amer. Journ. Sci., iv. (1907) pp. 24–331.

Water-heated Stage.*—This apparatus (fig. 18) is for the study of preparations at temperatures between 0° and 100° C. As may be seen from the illustration, it consists of a central chamber mounted in a metal plate, and communicating immediately with two thermometer chambers, through which the water from any convenient circulating apparatus enters and leaves. The thermometer chambers are so arranged that they can be lagged, and all metal surfaces are nickel-plated to check loss of heat. The central chamber is closed above and below by stout 1-in. cover-glasses, its lower side being $\frac{3}{32}$ in. away from the surface of the Microscope-stage on which the apparatus rests. Metal plates with any special form of cell, and of any depth up to $\frac{3}{8}$ in., can be readily fitted and are interchangeable. The three joints are made water-tight by rubber washers.

The special advantages of the apparatus are :—1. The interchange-

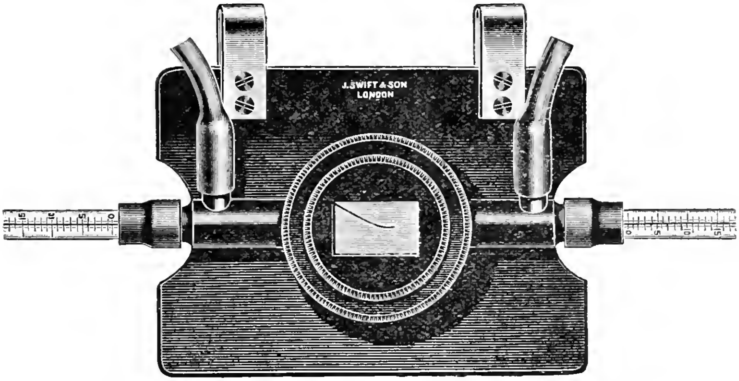

FIG. 18.

ability of washers and cover-glasses in case of breakage. 2. The adaptability at small cost to any form of cell desired. 3. The small distance between the chamber and the stage of the Microscope, permitting the use of a condenser. The apparatus is specially adapted to the study of extinction angles and other properties in crystal sections, but small-scaled preparations of any nature can be examined with equal facility.

(5) Microscopical Optics and Manipulation.

Optical Character of the Faint Interference-figure observed in High-power Objectives between Crossed Nicols.†— F. E. Wright points out that to the petrologist the appearance under crossed nicols of a faint, apparently uniaxial interference-figure in an objective of short focal length is a matter of common observation. It was at first considered to be the result of strain in the objective lenses, but Rinne,

* James Swift and Son's Catalogue, 1914, p. 25.
† Journn. Washington Acad. Sci., iv. No. 12 (June 19, 1914) 9 pp. (2 figs.).

in 1900, gave the correct explanation of the phenomenon, and ascribed it to the rotation of the vibration plane of the transmitted plane-polarized waves at the steeply inclined lens surfaces. It will be readily understood that a spherical surface may be considered to consist of a series of minute planes inclined at all angles with the vertical and in all azimuths. The rotatory effect of such a surface on transmitted plane-polarized light waves is, therefore, different in different directions, the result being a distinct uniaxial cross, with quadrants whose intensity of illumination increases with the distance from the centre. This is, in brief, the explanation of the faint uniaxial cross which appears in all high-power objectives between cross nicols. The plane-polarized light waves whose normals are parallel to the principal planes of the nicols suffer no rotation, while all others are rotated to an increasing extent as their azimuth increases, until the maximum rotation at 45° is reached. The reasons why these phenomena are so much more distinct in high-power than in low-power objectives are (1) the larger numerical aperture of high-power objectives, and (2) the fact that in such objectives the front lens of the system is a small uncorrected glass hemisphere, at whose steeply inclined sides the transmitted light waves are rotated through relatively large angles. The author gives a full account of experiments and observations which confirm his explanation.

New Half-shade Apparatus with Variable Sensibility.*—F. E. Wright describes the following apparatus, which he has used for working with Fresnel's equation, $\cot B = \cos^2(i - r) \cot A$. He mounts a plane-parallel glass plate so that it can be rotated about a horizontal axis in the first (N.E.) quadrant midway between the principal nicol planes. The azimuth angle A for incident waves from the polarizer becomes, therefore, 45° for all angles of incidence i, and the angle of rotation of the transmitted waves can be calculated from the simplified Fresnel equation, $\cot B = \cos^2(i-r)$. If, now, a second glass plate be taken and rotated about an axis in the second (N.W.) quadrant, the azimuth angle of the incident light waves from the polarizer is $-45°$, and the Fresnel equation reduces to $\cot B = -\cos^2(i-r)$. For a given angle of incidence the angle of rotation produced by the glass plate in the second quadrant is accordingly equal in value to that in the first quadrant, but opposite in sign. If, now, two glass plates be so mounted that they meet in a fine line, they form a half-shade apparatus of a definite angle of rotation. The author describes his method of mounting these plates, and gives a table of his results.

Determination of the Relative Refringence of Mineral Grains under the Petrographic Microscope.†—F. E. Wright points out that in many instances, especially in the measurement of the refractive indices of fine grains immersed in refractive liquids, it is extremely difficult to detect the faint differences in light intensity which appear at the margins of the grains, and by means of which the differences in refractivity are recognized. Under such conditions the eye of the observer is subjected

* Journ. Washington Acad. Sci., iv. No. 12 (June 19, 1914) 5 pp. (2 figs.).
† Journ. Washington Acad. Sci., iv. No. 14 (Aug. 19, 1914) 4 pp. (1 fig.).

to severe strain and tires quickly. Fortunately, however, it is possible, by modifying the conditions of observation slightly, to render the phenomena more easily visible, and thus to relieve the eye-strain to a large extent, and at the same time to increase the accuracy of the determinations. These modifications involve both the sources of light and a new method of two-fold oblique illumination.

Sources of Light.—In place of the sodium-flame ordinarily used as source of monochromatic light, the following light sources have been substituted: Mercury light, helium light, and either a calcium-flame or a molybdenum- or tin-spark. With this array of lights set up side by side on the dark-room table, and in conjunction with a monochromatic illuminator, or a dispersion prism or suitable ray filters (Wratten mercury-line filters), the following spectral line sources are available: $\lambda = 546 \cdot 1$, 558 to 561 (average about 560), 577 and 579 (average 578), and 588 $\mu\mu$. With these lights it is not difficult to determine between which two of the four available lines (546, 560, 578, 588 $\mu\mu$) the refractive indices of mineral and liquid coincide, the liquid having the higher refractive index for the shorter wave-length, and the mineral the higher index for the longer wave-length. Now, the refractive index of solids increases about $0 \cdot 001$ for a decrease in wave-length of 10–20 $\mu\mu$, while for liquids the change is approximately twice as great. If, therefore, the refractive index of a mineral be accurately measured for any wave-length between 546 and 588, its index for the wave-length 589 $\mu\mu$ (D line) can be estimated with an error not exceeding $\pm 0 \cdot 001$, and a liquid then prepared of exactly this index, whereupon the estimated refractive index of the mineral grain can be checked by immersion in the new liquid. By use of this arrangement a considerable amount of time has been saved in the routine measurement of the refractive indices of fine crystal grains. Occasionally the monochromatic illuminator (Hilger type, with Nernst light filament and ground-glass diffusing screen) has been found useful for ascertaining approximately the wave-length for which the refractive index of the grain coincides with that of the enveloping liquid.

New Method involving Two-fold Oblique Illumination.—Oblique illumination is obtained ordinarily by means of a sliding stop below the condenser of the Microscope. This stop is purposely not sharply imaged in the object-field, but appears as a shadow with a hazy edge, which passes gradually into the brightly illuminated part of the field. The mineral grains are placed in this transition shadow-edge between light and dark, and the illumination of their edges both in white and in monochromatic light is observed. Because of the prismatic refraction of the inclined edges of such grains, the intensity of illumination of edges adjacent to the shadow is different from that of the opposite edges, when the refractive index of the grains is different from the refractive index of the liquid in which they are immersed. These differences become less distinct as the refractive index of the liquid approaches that of the mineral; and, if the refractive indices differ by only $\pm 0 \cdot 001$, the intensity differences in illumination are difficult to see, because of the relatively large amount of light in the field. To reduce the field illumination, and thus to increase the differences in

relative intensity of illumination, and to render them more clearly visible, a double-stop device has been found useful.

This device consists essentially of two safety-razor blades mounted in a horizontal position to a vertical connecting-bar, which in turn is attached to the side of the stage-support of the Microscope. These blades are so adjusted that as the lower blade swings into position below

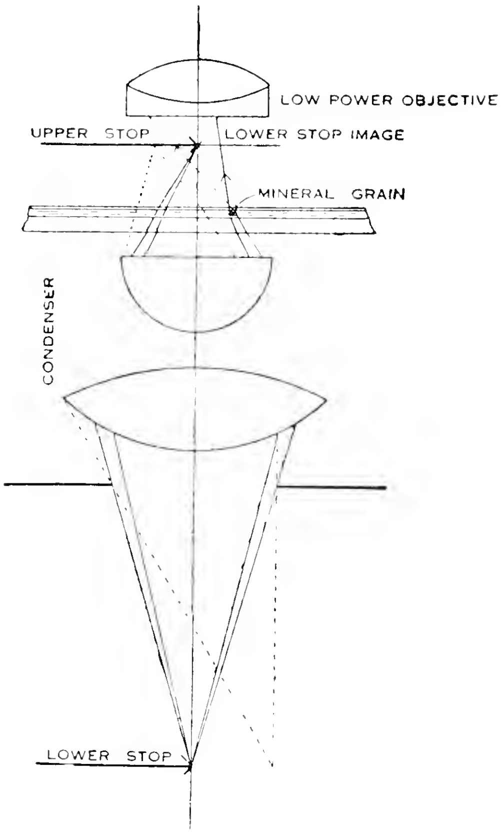

FIG. 19.

the condenser, the upper blade is brought to rest in the conjugate image-plane above the condenser and between the objective and slide. The upper stop is so adjusted that its knife-edge faces the knife-edge of the image of the lower blade. In case these two edges just meet, the entire field of view appears very weakly illuminated and is almost dark. The path of the rays is indicated in fig. 19. The effect of the refracting mineral grain is to disturb the path of the transmitted rays, so that

instead of focusing sharply in the image-plane they are deflected (as indicated with the two rays with arrows in fig. 19), and are thus able to enter the low-power objective (E.F. 16 mm.), and finally to reach the eye of the observer. If a mineral grain immersed in a liquid of slightly different refractive index be examined under these conditions of illumination, its edges appear in part brighter, and in part darker than the field. The intensity of illumination of the field is so weak that the illumination of the edges is clearly marked even for differences in refractive index of only $\pm 0 \cdot 001$, and the eye suffers no appreciable strain in making the observation. If now the upper blade be moved away from the edge of the image, a small amount of direct light from the condenser enters the field, and the phenomena produced by oblique illumination from the lower stop are observed under reduced field illumination. As the upper blade recedes, the field illumination increases, until finally the conditions of ordinary oblique illumination are reached. The phenomena observed under the first set of conditions are, moreover, the reverse of those produced on withdrawing the upper stop: the edges which appeared bright in the first case are dark in the second, and *vice versa*. This reversal, caused by the shift of the upper stop, is an additional factor which adds to the sensitiveness of the method. The movable upper stop not only increases the distinctness of the ordinary phenomena of oblique illumination by reducing the field illumination, but it also enables the observer to reverse the phenomena, and to study the slight differences in illumination against a dark field, for which the eye is more sensitive.

(6) Miscellaneous.

MERLIN, A. A. C. E.—**On the Minimum Visible.**

[The author reviews many examples of measurements of very minute magnitudes.]

Journ. Quekett Micr. Club, xii. (Nov. 1914) pp. 385–92.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Studies in Amœbic Dysentery.†—In the course of an abstract by Schill (Dresden) of "Studien über Amöbendysenterie," by K. Ujihara,‡ the following method is given for the examination, by means of enrichment, of encysted amœbæ.

The fæcal matter, containing cysts, is first filtered through gauze, and 60 c.cm. of the filtrate is then mixed with 30 c.cm. of glycerin, the specific gravity of the resulting mixture amounting to about 1070. The

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, etc.; (6) Miscellaneous.

† Centralbl. Bakt. Ref., lxii. (1914) pp. 316–18.

‡ Zeitschr. f. Hyg. u. Infectionskrankh. Bd. 77, 1914, p. 329 *et. seq.*; and Mitt. d. Med. Gesellsch. zu Tokio, Bd. 28, 1914.

filtrate is then centrifuged and water is added till the specific gravity is reduced to 1060. After repeated centrifugalization, the sediment is washed several times with salt solution, shaken up with 20 p.c. antiformin solution and again centrifuged and washed. The precipitate is then mixed with 10 c.cm. water containing five to ten drops of hydrochloric acid, centrifuged and again washed. On microscopical examination of the resulting precipitate, numerous cysts can now be found, which may be stained readily with neutral red solution.

Simple Cultural Method of Distinguishing Diphtheria from Pseudo-diphtheria Bacilli.*—G. Schmidt has reviewed a paper by M. af Heurlin, which appeared recently in the Münch. Med. Wochenschr., in which the author has employed a new medium for the differential cultivation of diphtheria and pseudo-diphtheria bacilli. This medium consists of a 1 p.c. agar medium with a 1·5 glucose content, and an addition of 100 c.cm. normal sodium carbonate solution to each litre. Fifty-three strains of true diphtheria were employed, and after fifteen to forty-eight hours, anaerophil or true anaerobic colonies developed. On the other hand, with most strains of pseudo-diphtheria the growth was unequivocally aerobic; principally on the surface of the medium, or as little points up to 8 mm. below the surface. The remainder of the pseudo-diphtheria strains employed did not produce any growth on this medium.

New Medium for the Cultivation of Chick Tissues in Vitro.†—H. F. Smyth has devised a method of growing chick tissues in vitro, in which the use of chicken plasma is done away with and an agar medium substituted therefore. After trying various combinations of egg albumen and agar, it was found that the following preparation gave the best results. Egg albumen was removed to a sterile Erlenmeyer flask, to which was added an equal amount of trypsinized pepton solution, prepared by dissolving 10 c.cm. Witte's pepton and 0·5 c.cm. trypsin in 200 c.cm. of Ringer's solution, and digesting for three hours at 40 C. The solution was then made up to 1 litre with Ringer's solution, boiled for twenty minutes, filtered and sterilized. A second solution (clarified with egg-white and stored in small flasks) was made by dissolving 15 grm. of agar in one litre of Ringer's solution. The mixture, when combined, was in the following proportions: egg albumen 25, trypsinized pepton 0·25, agar 0·75, and Ringer's solution 74. It gives a soft agar, rich in egg albumen, reinforced by partially digested pepton. It is easy to prepare, is very efficacious, does not solidify if kept above 42° C., and the contained albumen will not coagulate if kept below 60° C.

Preparation of Hæmatin.‡—J. A. Menzies describes the following method of preparing hæmatin, which appears to be an improvement on the potassium carbonate method usually employed.

Add to blood one-fourth of its volume of syrupy solution of potassium carbonate, place in a porcelain capsule and heat on a water bath till it

* Centralbl. Bakt. Ref., lxii. (1914) pp. 389–90.
† Journ. Med. Research, xxxi. (1914) pp. 255–9.
‡ Proc. Phys. Soc., xlix. (1914) pp. iv–v.

sets to a dark brown coagulum. The coagulum is then broken up with a glass rod and added to twice its volume of absolute alcohol or methylated spirit. A dilute solution of alkaline hæmatin is readily obtained by this method in a few minutes. For complete extraction, the mixture is allowed to stand overnight, when, on filtering off the solution, a dark, tarry fluid, consisting of alkali hæmatin with some alkali and lipoid substances, is obtained. The residue may be rubbed up with 66 p.c. alcohol to extract the remainder of the hæmatin. The solution may be neutralized with hydrochloric acid, when the hæmatin is precipitated. The precipitate is purified by successive washings with distilled water, alcohol and ether. The hæmatin may also be precipitated by adding twice its volume of ether to the solution, or by the use of calcium chloride and ammonia, or with baryta mixture. These precipitates may be washed with dilute hydrochloric acid, to remove the precipitated carbonate, then with distilled water, alcohol and ether.

Cultivation of Tubercle Bacilli from Sputum and Fæces.* — S. A. Petroff has elaborated a new and rapid method for the isolation and cultivation of tubercle bacilli directly from sputum and fæces. In each case the material is digested in a solution of sodium hydrate, and cultures made subsequently on special media. The medium employed consists of egg, beef or veal juice and gentian violet, and is prepared as follows. Sterilize the shells of the eggs by immersion for ten minutes in 70 p.c. alcohol, or by pouring hot water upon them; break the eggs into a sterile beaker, and after mixing well, filter through sterile gauze. The meat juice is prepared by infusing 500 grm. of beef or veal in 500 c.cm. of a 15 p.c. solution of glycerin in water. Twenty-four hours later the meat is squeezed in a sterile meat-press and collected in a sterile beaker. One part by volume of meat juice is added to the eggs and a sufficiency of 1 p.c. alcoholic gentian violet to make a dilution of 1 in 10,000. The medium is tubed in sterile test-tubes and inspissated for three successive days; on the first day at 85° C., on the second and third at 75° C. For cultivations of the bovine type of bacillus omit the glycerin and infuse the meat for 24 hours in water.

For isolating the bacilli from sputum, equal parts of fresh sputum (about 5 c.cm.) and 3 p.c. sodium hydrate are well shaken and left in the incubator for twenty minutes, or till the sputum is fairly well digested. The sputum is then neutralized to litmus, centrifugalized, and the sediment inoculated into the above-described medium. By employing this method 69 positive cultures were obtained from 69 specimens of sputum from practically all stages of tuberculosis, six being negative by direct microscopical examination. In many cases the growths were in pure culture, the inhibitory effect of the gentian violet killing out all extraneous organisms.

The method advocated for isolating the bacilli from fæces consists in collection in wide-mouthed jars, diluting with three volumes of water and filtering to remove solid particles. The filtrate is then saturated with sodium chloride, and the floating film resulting is mixed with an equal volume of sodium hydrate. After digestion and neutralization

* Journ. Exper. Med., xxi. (1915) pp. 38–42.

the sediment is inoculated into tubes of the special medium. Of 32 specimens examined, 9 were positive, 6 contaminated, and 7 were negative. Two of the positive cultures were inoculated into guinea-pigs, both of which contracted tuberculosis.

Immunization of Rodents against Naturally Pathogenic Paratyphoid Organisms.*—J. Danysz and Z. Skrzynski have attempted to protect mice and rats against infection with *Bacillus typhi murium, type B* (which is a paratyphoid organism naturally infective for these rodents) with entire lack of success. They employed the following techniques in these attempts—(*a*) vaccination with heated cultures or emulsions (Method of Chantemesse) in one, two or three injections: (*b*) vaccination with ether-killed cultures (Method of Vincent); (*c*) vaccination with cultures killed by dry heat at 75° C. (Method of Lœffler); and (*d*) vaccination with sensitized cultures killed by dry heat at 75° C. (Modification of Besredka's Method).

As stated, it was found to be impossible to vaccinate the mouse by any of these methods or to obtain from it a specific serum. From this fact the authors infer that the mouse does not possess any natural defensive mechanism against infection by the organism. The rat, however, is almost as difficult to vaccinate, though much less sensitive to the disease, and consequently one is driven to conclude that this is due to an inherent peculiarity in the nature of the microbe. Guinea-pigs and rabbits, on the other hand, are very easy to vaccinate against *B. typhi murium, type B*. These animals are refractory to infection per os or by subcutaneous inoculation, but readily succumb to peritoneal infection. The authors therefore conclude that the possibility of immunizing animals naturally resistant to a disease, against an infection artificially provoked, does not permit one to conclude that it is possible to immunize by the same methods animals naturally sensitive to the same disease.

Adaptation of Lactose Fermenting Organisms to the Medium in which they are grown.†—C. Richet has published a memoir on the above subject in which he demonstrates that an organism that has lived on a medium A grows more easily on the medium A than an organism of the same origin which has grown upon a medium different from A. The organism thus becomes accustomed to the medium A and transmits this peculiarity to its descendants. In estimating the measure of acidity produced by lactose-producing organisms in mixtures containing various quantities of toxic substances the technique employed was as follows:—

To cow's milk was added an equal quantity of distilled water, followed by a few drops of phthaline; potassium hydrate being introduced until a suspicion of a pink colouration appears. No more potash than necessary should be added, as during the subsequent sterilization, caramalization of the lactose is apt to occur and thus obscure the end reaction. Ten c.cm. of the solution, accurately measured, is delivered

* Ann. Inst. Pasteur, xxix. (1915) pp. 55–70.
† Ann. Inst. Pasteur, xxix. (1915) pp. 22–54.

into a series of U-tubes, which are then plugged and sterilized for three minutes at 110° C. The toxic substances are added to the media in definite proportions. When toxic substances are added in the place of distilled water they are added in double strength to the content required in the mixture; thus if the toxic content needed is A per litre, a solution containing 2A per litre is added, and so on. The inoculation and the growth of the lactic organism in the tubes containing various chemicals in solution and in the control-tubes containing distilled water is arranged to take place as far as possible under identical conditions of temperature, and so forth.

The following table, which is a summary of the results obtained with three different concentrations of the toxic substances (A) used, compared in each case with similar experiments conducted with controls containing distilled water (N), shows quantitatively the amount of lactic acid produced by a ferment A (the action of a similar ferment N being in each case 100) when it is allowed to actuate solutions free from or containing varying quantities of the substance which produced the strain A :—

—	0·00	A/2	A	2A
Selinate of Potash	85	115	138	164
Phosphate of Potash	89	118	199	206
Azotate of Potash	75	100	138	183
Sulphate of Potash	104	122	136	138
Chloride of Soda	107	111	120	138
Bromide of Potash	79	108	126	153
Arsenate of Soda	81	119	138	174
Nitrate of Thallium	78	104	120	153
Saccharose	99	115	132	123
Mean	88	112	138	159

These figures prove the adaptation of the organism to the toxic substances, and also show that a diminution of ferment activity takes place when the organisms which have been accustomed to grow in the presence of such toxic substances are again allowed to grow in normal milk. The only exceptions to this are to be found in the cases of sulphate of copper and sodium chloride.

Testing Antiseptics.*—W. W. Cheyne, in a lecture before the Royal College of Surgeons, stated that in co-operation with A. May, Bassett-Smith and A. Edmunds, experiments had been made to test the value of certain antiseptics with reference to the treatment of wounds in war. The technique, in their own words, is as follows :—

"Speaking generally, the plan which we have ultimately adopted as regards agar, is to place the antiseptic paste to be tested on the bottom of a Petri dish underneath a slab of nutrient agar, and to paint the upper surface of the agar with an emulsion of bacteria of various kinds,

* Lancet, clxxxviii. (1914) i. pp. 419-30 (1 pl.).

according to circumstances. We were then able to judge of the diffusibility and activity of the antiseptic by observing the growth or absence of growth of the bacteria which we had planted. Now, a comparative test is only of value if all the conditions are exactly the same, and I think we have ultimately worked out a satisfactory method. We always use the same quantity of the paste by weight, either $\frac{1}{2}$ grm. or 1 grm. as we wish. This is placed on an ordinary microscopical cover-glass, either $\frac{3}{4}$ or 1 in. in diameter, which is applied to the centre of the under-surface of the slab of agar. In this way the antiseptic is applied to the same definite area ($\frac{3}{4}$ or 1 in.) of the agar in all cases. Where fluids have been tested they have been put into a small paraffin cell containing pieces of filter-paper, and always in definite quantities.

"The slabs of agar must also always be of exactly the same thickness, and here we had our greatest difficulty. We began by pouring the agar into a Petri dish, till, as far as we could judge, we had got the proper depth of agar, and then allowed it to solidify and turned it out into another Petri dish, in the centre of which the paste was laid. After all, however, this was only guesswork; the table might not be level, and one side of the agar might be thicker than another, and besides we could not always be certain that we had put the same amount of agar into each dish. This difficulty has been overcome in a very ingenious manner, and though when two or more men work together it is not usual to refer to any one man's share in particular, still in this instance the arrangement is likely to be very useful in similar experiments in future, and therefore I think I ought to say that it was devised by Edmunds, and I shall speak of it as Edmunds's cell.

"To make an Edmunds's cell you take two square pieces of glass, a brass ring of known thickness (we generally have used one $\frac{1}{4}$ inch thick), the ring being incomplete in one part, and two or three broad paper-clips. First sterilize a glass plate in the flame and then lay it down on a dish, then similarly flame the interior of the brass ring and lay it down on the glass, then flame the other piece of glass and lay it over the brass. Bind these together by the paper-clips and you have a cell with an opening at one part through which the melted agar can be poured and left to solidify. When the agar has solidified the cell is laid down flat, the clips removed, the upper glass plate and the brass ring lifted off, and then we have the slab of agar lying on the lower glass plate. The cover-glass with the paste is now placed on the centre of this slab, with the paste next the agar, and then the lower part of a Petri dish is inverted over it, the whole turned upside down, and with a little manipulation the slab is transferred to the dish. A thin emulsion of the bacteria to be employed is previously made and is now brushed over the whole surface with a camel's-hair brush. Finally, a little fluid agar is run round the edge of the slab, partly to fix it to the dish and partly to prevent the escape of vapour should the antiseptic to be tested be volatile.

"As regards bacteria, we have chiefly employed the ordinary pus organisms, the *Staphylococcus pyogenes aureus*, but we have used *Micrococcus prodigiosus* and also *Bacillus subtilis* so as to study the effect on spores. It will be very interesting, when we have time, to study

other organisms. The Petri dish thus prepared is placed in an incubator at the body temperature, and observations made from time to time."

The most effective disinfectants appear to have been carbolic acid and tricresol.

Purification of Silk Pepton for Bacteriological Purposes.*—J. Walker Hall says that the tetra-peptid sold as silk pepton has certain advantages for bacteriological purposes over complex mixtures like Witte's pepton. Methods are described for purifying the crude product; the pigment may be removed by filtration through *Argilla alba*. The product has the same optical rotation and amino-acid content as that obtained by phosphotungstic acid precipitation.

Cultivation of Plasmodia of Bodhamia Utricularis.†—A. E. Hilton has found that the growth of a plasmodium of *B. utricularis* can be stimulated by the occasional application of a mixture of ammonium phosphate and cane sugar, half an ounce of the phosphate and the same weight of sugar being dissolved in a quart of water.

In the second place, he finds that the plasmodium will feed and grow

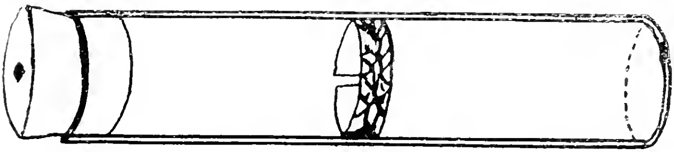

FIG. 20.

on bread kept moistened with water, especially if some of the mixture described be added to it from time to time.

The effect of the mixture seems to be both direct and indirect. It appears to impart greater vigour to the plasmodium, so increasing its feeding capacity; and it also benefits the plasmodium indirectly by promoting the growth of filamentous moulds, such as *Aspergillus* or *Penicillium*, which soon appear on fungus or bread after the mixture has been applied to it. The hyphæ of these moulds are dissolved and absorbed by the protoplasm as food.

The author then describes his method of exhibiting the reversing currents of streaming plasmodia.‡ The very simple arrangement is shown in fig. 20.

A tube of this size is sufficient, and a ring of blotting-paper, with sclerotium upon it, is placed inside; the sclerotium being between the paper and the glass. A few drops of water are added, the cork is inserted, and the tube is then tilted and revolved until the water has soaked the paper and moistened the whole of the interior surface of the tube. A small hole is bored through the cork to admit air without allowing too much evaporation; or the cork may occasionally be

* Journ. Pathol. and Bact., xix. (1914) pp. 286–304; through Journ. Chem. Soc., cvii. and cviii. (1915) i. p. 46.

† Journ. Quekett Micr. Club, xii. (1914) pp. 381–4 (1 fig.).

‡ See this Journal, 1909, p. 196.

removed. If necessary, a drop or two of water can be added now and then, to keep the air moist. Only plain water should be used. When the sclerotium revives, the plasmodium creeps on to the glass on either side of the ring of paper, and the reversing currents can then be seen by placing the tube on the stage of the Microscope and throwing the light up through it from the mirror beneath. A 1-inch objective, focused on the veins of the spreading plasmodium, shows the streaming movements quite plainly. The sclerotium should be placed in the tube the day before the plasmodium is required for exhibition.

New Collecting Tube.*—A. M. Banta states that the pipette described below (fig. 21) is very useful for pond-life purposes, and will collect any small or delicate object up to 6 or 8 mm. in diameter. It is made from a calcium-chloride tube about 200 mm. long and the ordinary 50 c.cm rubber bulb. The calcium-chloride tube used in the pipette figured consists of a glass bulb about 35 mm. in diameter blown in a glass tube of 16 mm. in diameter and about 120 mm. long. One end of the tube is heated in the flame and drawn out to the desired

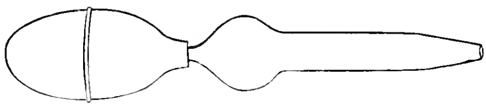

FIG. 21.

diameter for the pipette-mouth. From the opposite end of the glass bulb there extends a tube about 6 mm. in diameter suitable for attachment of the rubber bulb.

(2) Preparing Objects.

Demonstrating the Development of Trypanosoma lewisi in the Rat-flea.†—E. A. Minchin and J. D. Thomson first extracted the viscera of the fleas and then examined them under the Microscope. If infected the cover-glass was removed and then dropped into a fixative, while the slide is exposed to the vapour of osmic acid for 10 to 15 seconds, and then removed to absolute alcohol for about 15 minutes, and then stained with Giemsa in the usual manner. For fixation of cover-slip films Schaudinn's fluid or sublimate-acetic were used, but though the results were good, Maier's modification of Schaudinn's fluid was afterwards adopted (H_2O 200 c.cm., C_2H_6O 100 c.cm., sodium-chloride 1·2 grm., $HgCl_2$ 10 grm.). The cover-slips are immersed in this fluid for 10 to 30 minutes or longer, and then passed through upgraded alcohols to 90 p.c., wherein they can be kept until it is convenient to stain them. The cover-slip films were stained with Heidenhain's iron-hæmatoxylin. When this process was completed the cover-slips were rapidly passed through Lichtgrün-picric-acid solution (Lichtgrün 1 grm., picric acid

* Science, xl. (1914) pp. 98–9 (1 fig.).
† Quart. Journ. Micr. Sci., lx. (1915) pp. 463–692 (10 pls. and 24 text figs.).

$\frac{1}{2}$ grm., absolute alcohol 100 c.c.), then washed in absolute alcohol, passed through xylol and mounted in balsam. Sometimes the preparations were unmounted by dissolving the balsam in xylol and after removing the hæmatoxylin by means of iron-alum were restained by means of Twort's stain.

Sections of stomachs of infected fleas were also made. The viscera were fixed in the strong Flemming fluid or in Maier's modification of Schaudinn's fluid. The fixatives were allowed to act for about one hour, and the Flemming's solution was found to give the better results. The fixed stomachs were placed, three at a time, on thin slices of amyloid liver and stuck on with a tiny drop of glycerin-albumin. After fixing the stomachs to the liver in 90 p.c. alcohol, they were imbedded in paraffin. Celloidin imbedding did not give good results. The most suitable thickness for the sections was found to be 6μ. Though numerous methods for staining were tried, only two gave satisfactory results, viz., iron-hæmatoxylin followed by Lichtgrün-picric in absolute alcohol, and Giemsa's method.

(5) Mounting, including Slides, Preservative Fluids, etc.

Mounting Diatoms in Oil of Cassia.*—H. Miles-Carter states that this is an excellent, cheap, easily obtained medium, and with it the image obtained is far stronger than with balsam. He proceeds as follows:—Cement to a clean glass slip, a thin glass or tin cell, using isinglass cement or hard paraffin wax. Have ready the cover with the diatoms dried upon it, fill the cell with oil of cassia, slightly warm the cover, and lower it on to the cell, being careful to avoid air-bubbles. Remove with blotting-paper the superfluous oil from the outside of the cell and cover, taking care not to allow any of it to get on the upper surface of the cover, and, having ready a pot of melted hard wax, run this (with the aid of a hot wire and small brush) into the space between the outer edge of the cover and the slip; do not allow any air-bubbles to remain, get them out with a hot needle. When the wax is solid, the superfluity can be cleaned off with a penknife to within $\frac{1}{8}$ in. of the edge of the cover, and the glass cleaned up with a piece of rag. Then run a hot wire round the edge of the wax on the slip, so as to ensure a sound junction with the glass, then trim up as before. Give two coats of thick collodion, and an hour later a good coat of seccotine. Put the slide aside for 24 hours, then finish with shellac varnish.

(6) Miscellaneous.

Elements of Microscopical Technique and Vegetable Histology.†—J. Ochoterena, who is the Director-general of Primary Education of San Luis, Potesi, has compiled a tract dealing with the elements of microscopical technique and vegetable histology. It contains 50 pages and 17 illustrations. The contents are common to all elementary works on microscopical technique, and the printing of the illustrations is very imperfect.

* Journ. Micrology, 1914, pp. 95–6.
† San Luis, Potosi, Mexico, 1914, Fasciculo i.

Metallography, etc.

Polymorphism of Zinc.*—G. I. Petrenko states that the polished surface of zinc cooled slowly from above its melting-point to 180° C. exhibited large polyhedra upon which comparatively few small ones were disposed promiscuously; the small polyhedra were more abundant when the metal was quenched at 360–330° C., but completely covered the surfaces of the large crystals when the metal was cooled to just below 300° C. The phenomenon was reversible, and is considered to indicate the occurrence of an allotropic transformation between 290° and 300° C.

Tensile Properties of Copper at High Temperatures.†—G. D. Bengough and D. Hanson have made tensile tests on copper at temperatures up to 1000° C., in oxidising, neutral, and reducing atmospheres, and have recorded the microstructure of the broken specimens. In order to preserve the actual edge of the fractures during polishing, the specimens were electroplated with a thin coating of nickel, on which a thick coating of copper was deposited, and were then cut through at the desired position and polished in the usual way. Satisfactory etching was obtained, with some difficulty, by using a 10 p.c. solution of ammonium persulphate containing excess of ammonia. In pure copper two types of fracture are distinguished, the low-temperature type which passes through the crystals, and the high-temperature type, observed in specimens broken at temperatures between 720° C. and the melting-point, which is intercrystalline. In the high-temperature intercrystalline fracture there is no distortion of the crystals. The results are considered to support the hypothesis of the existence in pure metals of an intercrystalline cement, highly elastic at relatively low temperatures, which loses its strength with rise of temperature much more rapidly than do the crystals themselves.

Annealing of Brass.‡—Commercial castings of the alloy copper 70, zinc 29, tin 1 p.c., contain a complex eutectoid, in which the light-coloured brittle tin-rich constituent appears to be the δ-phase of the copper-tin system. On heating, this eutectoid is transformed to homogeneous β at about 600° C., and at higher temperatures the β diffuses into the α solid solution. F. Johnson has examined a 70–29–1 tube-casting which cracked badly during the drawing process. The casting contained intercrystalline eutectoid, through which the cracks frequently ran. The presence of the brittle eutectoid, the cause of the cracking, indicated that the casting had not been sufficiently annealed.

* Journ. Russ. Phys. Chem. Soc., xlvi. (1914) pp. 176–78, through Journ. Soc. Chem. Ind., xxxiii. (1914) p. 1212.

† Journ. Inst. Metals, xii. (1914, 2) pp. 56–88 (21 figs.).

‡ Journ. Inst. Metals, xii. (1914, 2) pp. 111–15 (9 figs.).

Embrittling of Brass.* — D. Meneghini examined worked brass (parts of incandescent gas-burners) which had become brittle in use, in some cases fracturing spontaneously. No change in composition was detected: the brass contained 35 p.c. zinc, 0·3 to 0·4 p.c. lead, and consisted almost wholly of the α solid solution. The softening resulting upon annealing at 700° C. indicated that the brass had been hardened by cold-work. The brittleness is ascribed to the effect of sulphur dioxide and moisture acting on brass in which internal stresses, caused by cold-work, existed.

Removal of Sulphur from Silver.† — C. C. Bissett has investigated the possibility of removing sulphur from silver by additions of copper or iron, and records some observations of structure of the melts prepared. When copper was added in increasing amounts to molten silver containing 13·5 p.c. of silver sulphide, the amount of sulphide remained fairly constant until 2 p.c. copper had been added. Further additions reduced the amount of sulphide, and the addition of more than 3·5 p.c. copper removed all the sulphide from the silver. When iron was added to molten silver containing 11·6 p.c. of silver sulphide, two liquid layers were formed, as in the case of copper additions, the upper rich in sulphur, the lower rich in silver. When a considerable excess of iron beyond that required to saturate the whole of the sulphur present was added, the upper layer contained all the sulphur, and the lower layer all the silver.

Copper-zinc-lead Alloys.‡—N. Parravano has studied the equilibrium of the copper-zinc system and the copper-zinc-lead system. Lead does not dissolve, in the solid state, in the α or γ copper-zinc solid solutions, and in lead brasses is found admixed mechanically with the copper-zinc alloy.

Widmanstätten Structure in Alloys.§—N. T. Belaiew points out that the Widmanstätten figures found in steel prepared under certain conditions are formed by the distribution of the structural elements between the cleavage planes during recrystallization, and are characteristic of the primary octahedral crystallization of the iron. Similar structures should occur in other alloys which crystallize in the regular system and undergo recrystallization after solidification; the primary octahedral crystals of the solid solution should throw out secondary deposits on their cleavage planes during recrystallization. A number of examples (brasses, bronzes, platinum-aluminium alloys, etc.) are illustrated by photomicrographs.

Coating Metals with Aluminium Alloy.‖— H. B. C. Allison and L. A. Hawkins describe a process in which articles of copper, iron or

* Annali. Chim. Appl. ii. (1914) pp. 154-8, through Journ. Chem. Soc., cvi. (1914) p. 849.

† Journ. Chem. Soc., cv. (1914) pp. 2829-36 (2 figs.).

‡ Gaz. Chim. Ital., xliv. (1914) ii. pp. 475-502, through Journ. Soc. Chem. Ind. xxxiv. (1915) p. 86.

§ Journ. Inst. Metals, xii. (1914, 2) pp. 46-55 (14 figs.).

‖ Met. and Chem. Eng., xii. (1914) p. 730.

some other metal are heated in a mixture containing finely ground aluminium. The effect is to form a coating of an aluminium-rich alloy on the article treated. This coating possesses remarkable resistance to oxidation on heating to high temperatures, and it is because of this property that the process is known as "calorizing." The microstructure of the coatings obtained on copper and other metals is described. There is a clear line of division between the unchanged copper and the alloy; the alloy is richest in aluminium at the surface.

Manganese Steel.*—J. H. Hall deals with the metallography as well as the manufacture, properties and uses of manganese steel, which commonly contains 9 to 14 p.c. manganese and 1 to 1·5 p.c. carbon. In the cast condition manganese steel consists of a ground-mass of austenite, containing manganiferous cementite in the form of a network, needles, and small masses. The cementite is bordered by austenite more or less transformed to troostite or sorbite. When the steel is heated to a sufficiently high temperature (1000 to 1100° C.), the cementite is dissolved in the austenite. If the cooling is rapid, the cementite is not liberated, but if the steel is cooled slowly, the cementite is liberated in a structure resembling that of the cast material. When the tough, quenched steel is reheated it becomes brittle owing to the separation of cementite as a fine network, and needles at about 500° C. If heating at 500° to 600° C. is prolonged for 24 hours, the austenite is transformed to sorbite and the steel becomes strongly magnetic.

Boron Steels.†—G. Hannesen has examined iron-boron alloys containing up to 8·5 p.c. boron. The compound Fe_5B_2 was found as needle-shaped crystals of rhombic section, and is magnetic. By quenching alloys containing 0·4 to 2·0 p.c. boron a martensitic structure was obtained, but in no case was an austenitic structure produced.

Honeycombing in Steel.‡—E. Crowe describes the structure of a crust of solid steel which had formed to a thickness of 4 to 6 inches on the top of the steel contained in a casting ladle, as a result of accidental long delay in casting. The underside of this top crust was honeycombed in a remarkable way. J. E. Stead puts forward the explanation that the gases given off in solidification had collected underneath the crust as bubbles, and the steel continued to crystallize round these bubbles.

Structure of Steel Castings.§—J. H. Whiteley found two distinct structures in a steel casting. On one side, large dendrites had formed, while on the other side the structure was not dendritic but granular. Examination of a number of castings, and experiments in which portions of molten steel were cooled quickly or slowly, indicated that slow cooling

* Journ. Soc. Chem. Ind., xxxiv. (1915) pp. 57–60 (1 fig.).

† Zeitschr. Anorg. Chem., lxxxix. (1914) pp. 257–78, through Journ. Soc. Chem. Ind., xxxiv. (1915) p. 84.

‡ Iron and Coal Trades Rev., xc. (1915) p. 327 (2 figs.).

§ Iron and Coal Trades Rev., lxxxix. (1914) p. 763 (Clev. Inst. Engineers, Dec. 14, 1914).

favoured the formation of a dendritic structure, and more rapid cooling produced a granular structure. In rolled material such as plates, the sulphide and silicate of manganese are often present in fine broken threads, as well as in the usual ellipsoidal form. The author suggests that the threads were originally cellular films in the ingot, while the ellipsoidal masses were globules.

Slag Inclusions in Steel.*—F. Giolitti and S. Zublena give the results of heat-treatment experiments on an acid open-hearth steel containing 0·38 p.c. carbon, and 2 p.c. nickel, intended to ascertain the effect of the slag inclusions present. The extent to which separation of ferrite round the inclusions occurred was influenced by the conditions of heating, whether carburizing or decarburizing. By appropriate heat-treatment, the injurious effects of slag inclusions may be diminished or even eliminated.

Annealing of Tyres.†—A. L. Babochine points out that the desirable structure in a steel tyre is a fine-grained sorbitic structure, and indicates the theoretical conditions for the production of such a structure by annealing. The tyre should be heated above A3 for a length of time sufficient to destroy the original structure, and to produce a uniform solid solution. Cooling to a temperature below A1 should be moderately rapid, and the subsequent cooling slow. In practice the annealing temperature should not be below 800°–840° C. The microstructures of tyres correctly annealed, and of tyres the annealing of which had been faulty in different ways, are illustrated by photomicrographs. Common faults in structure are coarsely lamellar pearlite, granular pearlite, and a coarse cellular structure.

Microscopical Investigation of Opaque Minerals.‡—O. Stutzer discusses the application in petrography of the microscopical examination of minerals by means of reflected light. Chalcopyrite, iron pyrites, pyrrhotite, and other coloured minerals can be detected in a polished section of the ore, while etching may be required to distinguish between minerals of similar colour. In nickeliferous pyrrhotite, the nickel is seen to be associated mechanically with the pyrrhotite in the form of pentlandite, whereas formerly it was considered to be in chemical combination in the pyrrhotite. In titaniferous magnetite the titanium occurs partly in mechanical association with the magnetite as ilmenite, and in part replaces the iron chemically in the magnetite molecules. Such specimens of titaniferous magnetite may be etched with hydrochloric acid, which dissolves the magnetite and leaves the ilmenite unaffected. In copper-iron pyrites, bornite $3\,Cu_2S, Fe_2S_3$, copper glance Cu_2S, chalcopyrite $CuFeS_2$, enargite Cu_3AsS_4, and iron pyrites FeS_2 may all be identified by their microscopical characteristics.

* Annali Chim. Appl. ii. (1914) pp. 218–245, through Journ. Soc. Chem. Ind., xxxiii. (1914) p. 1210.

† Rev. Soc. Russ. Met., i. (1913) pp. 387–705, through Rev. Métallurgie, xi. (1914), Extraits, pp. 594–599 (9 figs.).

‡ Metall. und Erz., xi. (1914) pp. 450–455, through Journ. Soc. Chem. Ind., xxxiii. (1914) p. 1160.

Microstructure of Coal.*—J. Lomax describes and illustrates by photomicrographs the structure of the different layers forming a typical coal seam. Most coal seams were originated by a regular deposition from the growth of vegetation on the spot where they were now found. The lower part of the seam consisted of a bed of very fine humus. Higher up the seam were remains of Cordaitiæ, a type of plant belonging to the Gymnosperms. Above these were Lycopods, which in the upper layers became predominant. Higher still in the seam the plant-life deteriorated, and the top layer resembled the bottom. It has been shown that the alternating dull bands and bright bands in coal differ in that the dull bands are more resinous. When coal is freed from the normal pressure in a seam, the more resinous bands expand, while the less resinous bands are cracked and pulled asunder by the unequal expansion. This appears to be the chief cause of the disintegration of coal into slack and dust.

* Iron and Coal Trades Rev., xc. (1915) pp. 46–48 (11 figs.).

PROCEEDINGS OF THE SOCIETY.

A SPECIAL MEETING

of the Society (under By-law 100) was held on Wednesday, February 17, 1915, at 20 Hanover Square, for the purpose of discussing the proposal for a new by-law forbidding the improper use of the letters "F.R.M.S." for advertising purposes. There were present Professor G. Sims Woodhead, M.A. M.D., etc., the President, in the Chair, and thirty-two Fellows.

The Secretary, Dr. Eyre, read the notice convening the Special Meeting, which had been circulated with the Proceedings.

The mover of the motion, Dr. Shillington Scales, being absent owing to ill-health, the President adjourned the Special Meeting *sine die.*

The President then declared the Meeting to be an Ordinary one, and the minutes of the Meeting of January 20, 1915, were read, confirmed, and signed by the President.

The following Donation received since the last Meeting was announced, and the thanks of the Society accorded to the donors :—

	From
Doncaster, L., The Determination of Sex. 1914 ..	*Cambridge University Press.*

Professor G. Sims Woodhead, M.A. M.D. LL.D., etc., then delivered his Presidential Address, on "Some of the Micro-biological Problems of the Present War."

On the conclusion of which,

Mr. J. E. Barnard said he felt sure he was only giving expression to the feelings of those present in saying how much they had enjoyed Professor Sims Woodhead's intensely interesting and very appropriate address. If he might say so, the Society was particularly indebted to Professor Sims Woodhead at this time, for he had stepped into the breach when the Society, in common with many other societies, was not free from difficulties, and had consented to take the responsibility of the presidency for a further term, when he was more than fully

occupied with other work. As to the address itself, it would be presumptuous on his part to express any opinion, much less to offer any criticism, but, if he might venture to do so, would draw attention to just one part of the question that had been touched upon, which was of the greatest importance, and one on which he felt very strongly. That was the satisfactory position at the Front, from the sanitary point of view, and the considerable influence that this would have in bringing the war to a successful issue. Perhaps the most important of the methods of preventive medicine was anti-typhoid inoculation. It was within the knowledge of us all, he said, that some people, well-intentioned, it might be, but sadly lacking in scientific insight, had been doing their utmost to dissuade men from being inoculated against typhoid fever.

We should perhaps extend our pity to those individuals who were so utterly incapable of appreciating facts that are put before them. They probably belonged to that class who still believed that the earth was flat, and were not to be convinced even by the statistics which had been given in the House of Commons only a few days ago, and which demonstrated beyond doubt or question the marvellous results that were being obtained. But in this case it was not a matter of opinion, it was a question of serious injury resulting to their fellow-men, and as such had nothing to justify it. The carrying out of these preventive measures might mean a shortening of the war that has already been disastrous enough. We were deeply indebted to Professor Sims Woodhead for having drawn our attention to these points, which, he was sure, were being so ably dealt with. In hygiene, Mr. Barnard said, it was no exaggeration to say that we were in the very front rank, and that no nation could show us the way, and he felt sure that Professor Sims Woodhead was one of the contributory causes to that state of affairs. He wished to move a hearty vote of thanks to Professor Sims Woodhead, and hoped that he would allow his Address to be printed in the Journal of the Society.

The vote of thanks to Professor Sims Woodhead for his Presidential address was carried with acclamation by all present.

The President, in reply, thanked those present very heartily for the warm way in which they had received his somewhat fragmentary remarks. He quite agreed with Mr. Barnard that the question of typhoid inoculation was one that could not be mentioned too often or insisted upon too strongly, and he thought that the statistics referred to by Mr. Barnard were in themselves very strong evidence of the value of anti-typhoid inoculation even after the patient had been attacked. For, if the figures were considered, it would be found that although there were more than 600 typhoid patients at the Front there had been a very low mortality, only 7·5 per cent; but it must be remembered that many of the men who went out had been inoculated. At home, where a far larger proportion are un-inoculated, and where the conditions otherwise should be much more favourable, the mortality during the same period was 18 per cent.

According to statistics, therefore, even if the patient should be attacked after inoculation, he had a better chance of recovery than if he had not been inoculated. Moreover, though this is not brought out by

the figures, which do not bear on the point, the percentage of patients attacked was very much lower among the un-inoculated. At one time there had not been a single death from typhoid of a properly inoculated soldier; he was not sure if this was still the case.

He again thanked the Fellows very heartily indeed for the way in which they had received his address. He should like to say, as he had said last year, that the Meetings of the Royal Microscopical Society were not only profitable but pleasant, for the reason that they had a common purpose and that they worked so harmoniously together for that common purpose.

He need scarcely add, in response to Mr. Barnard's request, that he should consider it a great honour to have his Address printed in the Journal of the Society.

It was announced that the next Ordinary Meeting would take place on Wednesday, March 17.

The next Meeting of the Biological Section would be held on March 3, at 7 o'clock in the Society's Rooms.

The following Specimens were exhibited :—

Professor G. Sims Woodhead :—Primary growth of *Meningococcus*—from Cerebro-spinal fluid; Secondary culture ditto, ditto; Cells from Cerebro-spinal fluid—epidemic Cerebro-spinal Meningitis.

New Fellows :—The following gentlemen were elected *Ordinary Fellows* of the Society :—Cyril O. A. Anderton, M.R.C.V.S.; and George Naylor.

MEETING

HELD ON THE 17TH MARCH, 1915, AT 20 HANOVER SQUARE, W., MR. D. J. SCOURFIELD, F.Z.S., VICE-PRESIDENT, IN THE CHAIR.

The Minutes of the Meeting of February 17 were read and confirmed, and were signed by the Chairman.

The Chairman, in announcing the donation of an old Microscope of curious design, said it had been presented by Mr. Sydney C. Akehurst, F.R.M.S., and after a few remarks from Mr. Rousselet in regard to its history, a hearty vote of thanks was accorded the donor.

In showing the presentation Mr. Rousselet said that this was a very interesting and well-made specimen of the early part of the 19th Century, not yet represented in the Society's collection; although there was no engraving or clue to indicate the maker, the style and workmanship may well have been that of Cary, who was in the habit of making small stands of various sorts, embodying features of earlier periods. The brass stand was made to incline by a compass joint at the base, and also has a brass clamp for fixing to a table. The focusing arrangement is similar to that used by Benjamin Martin, the screw being clamped to the square stem and the fine screw then moves the stage, which also has a screw movement. The optical part consists of a single lens of low power.

Mr. Edward J. Sheppard, F.R.M.S., then read a paper on "A New Mitotic Structure Disclosed as the Result of New Technique," which appears *in extenso* in the Society's Journal.

The Chairman, in the name of the Society, thanked Mr. Sheppard for his most interesting and instructive paper, and invited discussion thereon by the Fellows present.

Dr. Hebb pointed out that the words "methyl-blue" had been used several times. Was it certainly methyl-blue, or was it methylene-blue? because the two stains were very often confused, and they were utterly different in their composition.

Mr. Sheppard, in reply, said that the stain he had used and described in his paper was methyl-blue as obtained from Grübler in capsuled bottles. It was possible that the previous treatment with iron and permanganate might have some very material action on the stain, but he was unable to speak definitely on this point. He would, however, investigate the matter further.

The Chairman called upon Mr. Hopkinson to read a paper by Mr. G. H. Wailes, F.L.S., entitled "Notes on the Structure of Tests of Fresh-water Rhizopoda."

Mr. Hopkinson said that he was in some measure responsible for this

paper as he had several years ago induced Mr. Wailes to take up the study of these beautiful microscopic creatures, and recently to write the paper for the Society. As it was too long to read in its entirety, he would omit nearly all the detailed results of the author's investigations, which would be better understood when in print.

After reading the earlier portion of the paper, he exhibited two lantern-slides which he had had made from the plate showing the minute structure of the tests, and explained some of the figures, drawing special attention to those which *appeared* to indicate a desire to most effectively combine lightness with strength, to use material most economically, and to produce the prettiest effects. He referred especially to the building of a test of hexagonal plates in two parallel layers joined together by transverse webs at the edges of the plates, and to the economic and artistic strengthening of the tests, for usually when in a test of circular scales openings are left, if these are equilateral a circular plate or disk is placed over them, and if oblong an oval plate, and in one of square scales or plates when the corners of four meet in one point, this, being the weakest part of the test, is sometimes strengthened by a minute square plate with its centre exactly over that point, and if the corners do not quite join in one point it is strengthened by an oblong plate so accurately fitted that its edges are equidistant from the corners of the scales.

The Chairman, in proposing a hearty vote of thanks to Mr. Wailes for his extremely interesting paper, and to Mr. Hopkinson for bringing it before the Society, said that the subject was of particular interest to him, as he used many years ago to pay special attention to the fresh-water Rhizopoda, and he was very much struck by the wonderful way in which the tests were put together. Mr. Wailes had given them many illustrations of these beautiful tests, and of the curious manner in which they were formed. He could not help thinking, however, that some of the smaller plates described might possibly be due to optical illusion, and he suggested that one of the new high-power binocular microscopes might be used with advantage to investigate this point. The structures were certainly worthy of intensive study.

The Chairman then invited comments on the subject-matter of the communication.

Mr. Heron-Allen offered some observations relative to the phenomena of purposive intelligence displayed by both fresh-water and marine Rhizopoda. It appeared to him that a consistent evolutionist would admit the continuity of an evolutionary cycle, and not postulate the sudden introduction at some point of a new influence to be called intelligence. It was therefore reasonable to suppose and to admit that the lowest orders of living things were endowed with a specialized intelligence which became apparent when they adopted extraneous materials to their individual needs whether for purposes of adaptation or defence.

Dr. J. Rudd Leeson dealt with this subject of intelligence in an even lower plane, referring to the remarkable and seemingly purposive action that took place in crystals, and illustrating his remarks on the blackboard. He said if an alum crystal was put into an alum solution

it would go on growing, but if before immersion a corner was knocked off the crystal would "mend" itself before it began to grow. Similarly every grain of sand (which is broken and rubbed quartz crystals) upon the sea-shore was always diligently mending itself from the silica contained in the sea-water. He spoke of the wonderful revelations of the Penrith sandstone: there the broken crystals could be seen mending themselves with such exactness that the "mend" was put on in actual optical continuity with the old grain—though any time in millions of years had intervened . . . . If this was not akin to "purposive action" he knew not what term to give it; here, he thought, were the elements of consciousness, of purposive acts adapted to ends, which no degradation of the term "mere matter" could deprive of the qualities of mind.

It was announced that the next Ordinary Meeting would take place on Wednesday, April 21.

The next Meeting of the Biological Section would be held on Wednesday, April 7, when the following communications would be made:—

1. "The Eel-worms of Wheat." By Mr. Albert Ashe, F.R.M.S.
2. "Androconia, or Scent-scales of Lepidoptera." By Mr. A. W. Sheppard, F.Z.S., F.R.M.S.

The Chairman further announced that by the kind invitation of Dr. Eyre a visit will be paid to the Bacteriological Laboratory, Guy's Hospital, on Wednesday, April 28.

The following Slides were exhibited :—

Mr. E. J. Sheppard, F.R.M.S.:—

1. Showing chromatin extensions and spindle fibres attachment to same. Stained methyl-blue and iron-hæmatoxylin (Heidenhain).
2. Same as No. 1 with the exception that the differentiation of the stains is not carried so far.

Subject: *Lil. aurat.*, Pollen mother-cells.

Mr. John Hopkinson, F.L.S., F.R.M.S.:—*Lesquereusia spiralis*, a fresh-water Rhizopod, with vermiform pellets on test, partly formed; ditto, with vermiform pellets on test, completely formed.

New Fellows:—The following were elected *Ordinary* Fellows of the Society:—Miss Lilian A. Francis, Sidney A. Milbank, M.B.A.A., Frederick O. Mosley, Frederick H. Taylor.

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

JUNE, 1915.

TRANSACTIONS OF THE SOCIETY.

IV.—*The President's Address: On Some of the Micro-biological Problems of the Present War.*

By G. Sims Woodhead.

(*Read February* 17, 1915.)

If, this evening, I leave well-trodden paths and wander in unaccustomed places, I would ask you to bear with me as with one who, from the call of unexpected duties, has had little time to devote to his ordinary avocations, and who has been compelled to turn his attention to the consideration of problems quite other than those with which he is usually occupied.

On the night that I was nominated to the honourable position in which you placed me two years ago, I heard a member say, "Oh! now that our new President is a bacteriologist and a doctor I suppose things will take a medical turn." I accepted this both as advice and as a warning, and, trying to keep before my mind the association of medicine and the Microscope, I have had, during the whole period, an evergrowing perception of how much modern medicine owes to the association.

For the past six months, however, when I should have been continuing, or perhaps even completing, certain work on the rate and conditions of growth of bacteria, the results of which I thought might be placed before you in the form of a presidential address this evening, I have had to devote much of my time and energy to practical sanitation—to ensuring the ventilation of hospitals for wounded soldiers, to the inspection of billets for Territorials and huts for new army recruits, and to the supervision of the drainage and construction of these hospitals and huts. Such work can be of little interest to the members, as members, of this Society, however

much it may appeal to them as loyal subjects of His Majesty and well-wishers of the brave men who are offering their all for a just cause and in defence of a great and delectable country. Whilst saying this, may I also say that I hate war and all that comes in its train, and I hate it the more because I feel, long as I tried to avoid the conviction that we had no alternative, that we must fight or be content to see the weak trampled on, the free fettered, liberty restricted and brute force worshipped as a fetish by a nation, hypnotized by the concentration of a self-conscious gaze upon its own intellectual achievements and material prosperity, and led or misled by a small but powerful, if not intellectual, caste of self-seeking and overbearing Prussian militarists. We go into this fight with a magnificent fighting force; to be efficient that force must be healthy. It must be well fed, it must be protected from disease, and its wounded must be well cared for. How much of the knowledge, the application of which ensures all this, do we owe to the Microscope? Preventive inoculation against enteric fever we owe to our penultimate President, Sir Almroth Wright, who, following in the footsteps of a great Russian, Dr. W. M. Haffkine, has done great things for our army. Moreover, he still continues his beneficent work at the front, studying the bacteriology of surgical wounds, study that must have a profound and far-reaching bearing upon the treatment of wounds, and must result in much saving of life and limb to the brave and cheerful men who take their place in the fighting line.

As an early disciple of the late Lord Lister I am naturally greatly interested in the controversy that is going on amongst surgeons—antiseptic surgery as against aseptic surgery. I do not intend to-night to deal fully with what is a very abstruse question, one mainly for the consideration of professional surgeons, but I do wish to draw attention to the arguments of those surgeons at the front who are now reverting, and I believe with good reason, to Lister's antiseptic surgery. Working as I did with Lister in the old Edinburgh Royal Infirmary many years ago, and comparing the results he obtained with those obtained, then and since, by other surgeons, I always call to mind two cases on which I followed his demonstrations with the keenest interest—two cases which illustrate very precisely the contentions of the two sets of surgeons. One was a compound fracture of the leg—the result of a railway accident—in which there had been considerable crushing of the bones and tissues. When the patient came into hospital the wound was soiled with earth and ashes, and there was evidently considerable devitalization of much of the crushed tissue. Lister went to work at once with great vigour and injected a strong solution of carbolic acid into the wound in order to wash out all foreign matter; he also removed crushed fragments of tissue and loose particles of bone. I enter into these details, gentlemen, because

they are of the essence of the whole matter. There were greatly damaged tissues in the wound, and the addition of the carbolic acid, whilst but an insignificant factor in the devitalizing of the tissues, by its presence enabled the operator to handle the parts and treat them much more thoroughly than would have been possible were sterile water only used. Moreover, the carbolic acid was expected to exert a distinctly devitalizing action on any bacteria that had been crushed into the wound; and Col. Griffiths, also one of Lister's disciples, maintains that the sterilizing influence of the carbolic acid extends for some little distance from the surface to which it is applied.* This is evident from the fact that this substance is absorbed and appears in the urine so readily when carbolic acid is applied too freely to large wounded surfaces. Here we have one set of conditions. The second case is now almost "classical." After the removal of a horny growth from the heel of a patient, a tremendous gap was left, and Lister conceived the idea of allowing the blood-clot to fill up this gap and so to form a scaffolding into which blood vessels from the surrounding tissues might make their way. He exposed and examined this blood-clot from time to time, and although he used an antiseptic dressing he was careful, as he pointed out, to keep as much of the antiseptic out of the wound as possible. The antiseptic shield he applied was to prevent the access of micro-organisms to the clot, not to sterilize the clot itself. He was specially insistent on this point, and, in another case that also clings to a place in my memory, he demonstrated that an abscess opened and cleaned out, perhaps by washing with carbolic acid, should always be left alone when once the healing process has begun. He recommended, therefore, that at this stage the antiseptic should be kept outside the abscess, and its use allowed only as a shield against the access of organisms that might set up putrefactive or other processes in the fluid draining into the abscess cavity and thus to the surface. Lister anticipated and considered fully the two aspects of the present-day controversy, and I am convinced that, as the outcome of the present war, there will be a modification in the ideas and practice of thoughtful surgeons. When comparatively healthy tissue is incised, and closed cavities to which micro-organisms have gained no access and around which the tissues are undamaged are opened up, it is obviously unneccessary to introduce antiseptics even of the least irritant type, as these antiseptics may, if acting upon tissues but slightly weakened, lower their resistance to the attacks of incurrent micro-organisms. They may even help the micro-organisms in their attacks on the tissues. It is desirable, then, to alter the surroundings of these weakened tissues as little

* This thesis has since been more fully elaborated by Sir W. Watson Cheyne, Fleet Surgeon Barrett Smith, and Mr. Arthur Edmunds, in the Journal of the Royal Naval Medical Service, 1915, vol. i. p. 103.

as possible. When, however, it comes to be a question of wounds received on the battle-field, the bruising, the torsion, the infiltration of filth, must result in the death of some of the tissues and great damage to others, and these dead tissues, offering a nidus for the growth and multiplication of the micro-organisms that have been introduced from without from whatever source, cannot be further damaged, whilst the micro-organisms contained in them may be destroyed by the action of a powerful antiseptic; the same micro-organisms, if left alone and at rest in their nidus, giving rise to septic and putrefactive foci, which ultimately may carry off the patient. I hope to have an opportunity of studying more carefully the observations of those working at the front, but I am convinced that the whole method of treatment of wounds, both at the front and at the base, will resolve itself into the use of the two methods suggested by Lister in the cases above mentioned, and the more closely his principles are followed, whatever antiseptics may be used, and however they are applied, the better will be the results obtained.

Lister, though a great master of detail, always worked along lines of great principles. He appeared to realize from the first that in all suppurative and septic processes two main factors were involved—the number, resistance, activity or invading power of the micro-organisms on the one hand; the vitality, nutrition and resisting power, either general or specific, of the tissues on the other. Dead tissues and fluids, especially when present in large masses, he looked upon as food easily ingested and assimilated by active micro-organisms; whilst healthy, active tissues he depended upon for the destruction of large numbers of weakly micro-organisms and of smaller numbers of more active and virulent micro-organisms. Dead tissue in itself might be harmless, but as a nidus for the multiplication and growth of micro-organisms, and therefore as a coign of vantage from which other tissues might be attacked, it was ever a source of danger, and should be removed as soon as possible. He also realized that accumulations of fluid, whether active or passive in any part, must always interfere with the nutrition, and therefore with the vitality, of the tissues in the immediate neighbourhood of the channels or spaces in which that fluid accumulated; whilst, as he was fond of demonstrating to his classes, there was, in all this, a vicious cycle completed by the malnutrition of the tissues leading to further accumulations of fluid, which fluid, having given up its nutrient elements and received in their stead a surfeit of effete matter, was no longer capable of helping to nourish the surrounding tissues. It was for this reason that Lister, though a most conservative surgeon, insisted on the removal of sloughs, dead tissue, separated fragments and extravasated blood from open and contaminated wounds, and even from wounds which were likely to be easily contaminated. Drainage he placed in the

forefront of his treatment of a cavity, whilst he never feared, in spite of his dislike to a surface lesion, to make free incision where fluid had accumulated in connective tissue and other spaces and could not be got rid of without such incisions; just as to-day a chronic or even certain acute forms of hydrothorax are treated almost as a matter of routine by the drawing off of the fluid that has accumulated in the thoracic cavity, the relief to the pressure within the thoracic cavity apparently being followed by a renewed activity of the lymphatic system in the immediate neighbourhood of the collected fluid, and by a comparatively rapid absorption or transportation by the lymphatics of the fluid that had accumulated and become stagnant in them.

Antiseptics may be used to prevent the access of germs to a wound, to kill the germs that have made their way into dead tissues, to help in the removal of dirt of all kinds and the accompanying germs, and of as much dead tissue as possible, and I am satisfied that by their use for these purposes the best surgical results will, in the long run, be obtained, whether at the front, at the base, or in the General Hospitals.

During the last month or two much has been written and talked about "frostbite." Now I am satisfied, from what I have seen and read, that many cases of so-called frostbite are not frostbite at all, but are the result of a stasis or accumulation in the lower limbs of the nutrient fluids that should be constantly circulating. Such cases correspond far more closely with a condition recognized by veterinary surgeons as occurring in horses that stand for long periods in their stalls, during lengthy sea voyages, for example. This condition appears to be the result of (1) impaired circulation of the blood, (2) interference with the circulation of the lymph, and (3) damage to the tissues induced by imperfect nutrition and diminished excretion of waste matter from the tissues. The heart unstimulated by exercise exerts less propulsive power than when the animal is undergoing active exercise, the arterial flow slackens, and the blood is not driven through the capillaries either so rapidly or so readily. Again, the muscles of the lower limbs, not being called upon to contract, the veins lying between them are not submitted to the pressure that results from healthy muscular contraction. As the valves in the veins allow the blood to pass in one direction only, the blood after passing through the capillaries is driven towards the heart whenever muscular compression is applied, but when the muscles do not contract this factor in keeping up circulation is wanting. This same lack of contraction leads to a similar stasis in the "valved" lymphatic vessels, and neither blood nor lymph is changed so frequently as under normal conditions; and the fluid kept long in contact with tissues, deprived of its nutritive properties, and receiving an excess of effete material, no longer supplies sufficient material for

the effective nutrition of these tissues, whose function and activity are correspondingly lowered. They are now unable to do their work properly, to retain the fluids within proper bounds to help in their circulation. Unless the causes are removed or the condition becomes gradually worse, until the lowering of vitality and function become so great that the evidence of their presence becomes marked. If the limbs are subjected to a low temperature, especially for a long period, the impairment becomes more evident; they become swollen and dropsical, a condition in which the nerves participate, and these latter, deprived of much of their nutrient supply, become functionally inert, though when this supply is being restored they may become so stimulated that intense pain may result.

In the trenches, as pointed out by Col. Griffiths, there is the additional factor of the water, which may exert some direct pressure upon the tissues of the lower limbs from without and so interfere with nutrition. This factor assumes still greater importance as the clothing, and especially boots, stockings and putties, when wetted tend to shrink, all this favouring the condition of "pressure starvation."

Such a condition is seen in miniature in the numbness followed by "pins and needles" in a limb from which the blood-supply is cut off temporarily. The numbness occurs because of the cutting off of the blood-supply to the nerves, say when we sit in a cramped position for some time, the "pins and needles" coming on as the blood-supply—nutrition—is restored.

The nerves, or other tissues, deprived of their full nutriment for a prolonged period may lose their function and become more or less permanently altered in structure, and the alteration may be so grave that only prolonged treatment, and, one might say, repair of the structures, can restore their function. There are cases, of course, in which the tissues are rapidly destroyed partly as the result of lowered temperature and partly, often, as the result of too sudden and too marked reaction—inflammation—of the tissues, but the majority of the cases of so-called frostbite appear to be, not inflammatory, but the result of impaired vascular and lymphatic circulation followed by malnutrition, more or less marked of all the tissues of the lower limbs, and œdema or dropsy of the delicate tissue supporting the nerve fibrils, and leading to a loss of nerve function, and even alteration in structure.

The men standing in the trenches suffer as does the horse standing in his stall. The treatment for the condition in the horse is regular and graduated exercise, and for that in the soldier the same, in the very early stages, and in the more advanced stages protection of the weakened tissues from extremes of both heat and cold, from injury and from irritation, in order that there may be as little inflammatory reaction as possible. The patient should be

kept in the recumbent position, with the limbs slightly raised; gentle massage, very gradually increased, should be applied, followed, as improvement occurs, by gentle and carefully graduated exercise. The condition of the tissues, as revealed under the Microscope, bears out the contention of the veterinarian that here we have altered nutrition due to imperfect circulation and accumulation of fluid in the connection tissue spaces.

Both of these problems are strictly micro-biological, but they are problems that have a tremendous bearing on surgical practice.

Splendid work, then, is being done at the front, whilst at home contributions have been made to the common fund of knowledge to be drawn upon for the better preservation of the health of our troops, and I propose to give a short account of a method devised for the testing and sterilization of water on a large scale, a method based on microscopical research, but one in which the Microscope, having served its purpose, is no longer necessary.

Nowadays, most of those who have worked at infective diseases are convinced that, although the accumulation of waste products in the tissues, resulting from fatigue or overfeeding, the lowering of vitality of the tissues by cold, wet, and bad ventilation, are undoubtedly predisposing or accessory causes of these diseases, specific micro-organisms, each reproducing its kind, are the exciting factors in the production of infective diseases. It is recognized, almost universally, that cholera, typhoid fever, dysentery and certain forms of epidemic diarrhœa are induced by specific bacteria which, adherent to particles in food and in water, and carried by flies, may be transported from place to place, and finally may attack susceptible individuals. Although none of these bacilli flourish and multiply in water as they do in milk and other organic media, they may retain their vitality in it for some time. A medium so readily infected is often a source of grave danger, sometimes giving rise to explosive outbreaks, especially of cholera and typhoid fever; and since hygiene became a science, one of the subjects to which hygienists have turned, again and again, is the production and maintenance of a water-supply free from the infective organisms that produce the above-mentioned diseases. Charcoal filters were tried and found wanting; indeed they often proved to be breeding grounds for the bacteria they were supposed to eliminate. Heating, sedimentation, filtration through Berkefeld and Chamberland-Pasteur filters were also tried in turn, and, under ideal conditions, each has given good results, though, under the rough conditions that obtain in the field, they have not been so satisfactory. There has been a lack of fuel, or the heating apparatus has not been available when it was most urgently required. Sedimentation has failed because sterilization can be obtained by this method only after a long period of settlement, and even then complete sterilization does not always result.

Again, although filtration through filter candles gives a sterile filtrate, the water does not come through quickly enough to satisfy a troop of thirsty soldiers, and then can only be obtained as the result of a good deal of hard work at the pump; and, from practical experience, it is found that those who have the charge of the water-carts, unless blessed with a very rigid conscience and a conviction that there is infective matter in the water with which they are dealing, are prone to lack care not to break—or, perhaps, low be it spoken, to take care to break—the filters. A cart can be filled through broken filters in less than a third of the time, or at any rate with the expenditure of less than a third of the energy required to drive the water through the unbroken filter candles. For many years I, with many others, have been seeking some method of sterilizing water by means of chemical reagents—reagents which would not alter the taste of the water, and would not render it flat, and that could be used in quantities well adjusted to effect complete sterilization and nothing more. Using ozone as a sterilizing agent I obtained excellent results. Then I turned my attention to the action of the ultra-violet rays as sterilizing agents. These latter are, undoubtedly, effective, but up to the present the machinery required to carry out the process is somewhat difficult to manipulate, and the whole process requires to be watched and regulated exceedingly carefully if satisfactory results are to be obtained. The sterilization of water by the addition of electrically produced ozone is, from many points of view, an ideal process. It sterilizes water, or rather it kills without fail the non-spore-bearing organisms which give rise to cholera, typhoid, and bacillary dysentery, whilst, in the quantities necessary to effect sterilization, it does not interfere in any way with the taste of the water unless there is a considerable quantity of organic matter present. It is, however, a somewhat costly process and requires for its successful application an expensive plant and skilled attention. Given these it may be looked upon as an ideal process, in that ozone is amongst the things that are popular, and no one would think of objecting to its addition to water. For poor communities the expense is, of course, prohibitory, whilst for field work the elaborate apparatus and power required must always constitute a difficulty. Many years ago, now more than I care to number, working with Dr. Cartwright Wood, I carried out a series of experiments with solutions of hypochlorous acid and hypochlorites made by passing a weak electric current through sea-water. We were much struck by the powerful bactericidal properties of this weak solution, especially when applied to the *Bacillus coli communis* and the typhoid bacillus. Even sewage containing an enormous number of these organisms had its contents of living bacteria markedly diminished, whilst

oxidation of any oxidizable matter was rapidly effected by the hypochlorous acid. We found, moreover, that it was possible to obtain from the hypochlorous acid contained in ordinary "chloride of lime" or "chloro-hypochlorite of lime" (bleaching powder) not only the same but far more powerful bactericidal and oxidizing effects, in that the electrolytic fluid contained only a comparatively small amount of the hypochlorous acid, a substance in which bleaching powder is so rich—33 p.c. of chlorine and a proportionate amount of oxygen. Using what we thought were weak solutions of this bleaching powder—some four or more parts of available chlorine per 100,000 of water or sewage—we obtained what were then considered most marvellous results in the way of bactericidal or sterilizing action. Indeed, we became almost afraid of our results, they seemed to be too good to be true, and we thought that there must be some underlying fallacy which had, somehow or other, escaped our observation; but although we were averse to pushing the results of our experiments to their logical conclusion, we satisfied ourselves that Professor Delépine, who had drawn attention to the wonderful disinfectant action of comparatively weak solutions of bleaching powder, was by no means overstating his case.

About this time I was asked by the authorities at Maidstone to undertake the sterilization of the whole of their reservoirs and water-mains. There had been a severe outbreak of typhoid fever in the town, and although no connexion between the outbreak of typhoid fever and the contamination of the water-supply could, at first, be traced, the authorities held, and very rightly, that precautions should be taken to cut out every possible source of infection (it was afterwards found that in all probability the water was infected, but from a source other than any suggested at the time of the outbreak of the epidemic). It was, of course, possible to sterilize the contents and walls of the whole of the reservoirs and water-mains, but in my ignorance I used a solution of chloride of lime at least 100 times as strong as was necessary. However, the desired object was attained, and, at a later date, when it was found necessary to sterilize the water derived from an infected river, during an outbreak of typhoid fever in Lincoln, Dr. Houston recommended the use of hypochlorous acid, this time, however, combined with soda instead of lime, as the sterilizing agent. The results obtained were excellent, but the expense was somewhat greater than if "chloride" or hypochlorite of lime had been used. It was claimed that the taste imparted to the water by the hypochlorite of soda was less marked and less objectionable than that given by hypochlorite of lime. For some time the matter remained in abeyance in this country except for contributions to the subject made by Professor

Delépine and Dr. Thresh, both of whom continued their allegiance to bleaching powder as a powerful bactericidal and disinfecting agent. In the meantime, in Massachusetts and other centres in the United States, numerous experiments were being tried, and the results obtained fully bore out what had already been observed in this country, both sewage and water of all types and qualities being sterilized by means of the addition of comparatively small quantities of bleaching powder.

For many years I have made bacterioscopic examinations of the Cambridge water, and, from time to time, have carried on small sterilizing experiments, as a result of which, as already stated, I early satisfied myself that ozone and chloride of lime were the only two substances at present available for the rapid and effective treatment of drinking-water. The production of ozone was, however, as already noted, an elaborate and somewhat costly process, whilst chloride of lime, though cheap and easily applied, in the proportions used and left unneutralized, usually gave a markedly unpleasant taste to the treated water; whilst, as the result of neutralization with thio-sulphate of soda, a very flat and insipid flavour was imparted to the water. Further, as a considerable number of organisms were found in the thio-sulphate solution, many of our cultivation experiments were rendered valueless; and although most of such organisms were derived from the unsterilized water used in making up the solution, it was evident that the thio-sulphate had little bactericidal action on any of the organisms present. Moreover, it seemed to me to be unnecessary to complicate the process; rather should it be simplified in every way possible, and I set out to find whether even smaller quantities of chloride of lime than any yet used were not effective. Ultimately I was delighted to find that although it is difficult to destroy the spore-bearing organisms met with in water, and even some of the ordinary saprophytic water organisms, it is a comparatively easy matter to kill off what one may classify as the non-spore-bearing micro-organisms whose usual habitat is the intestinal canal. I therefore concentrated my efforts on this type of non-spore-bearing organism. Using the amounts of chloride of lime that had been used by the American investigators and by Dr. Thresh, I found, as did they, that the presence of organic matter in solution and even particulate matter in the water, along with *Bacillus coli communis*, invariably led to a diminution of the bactericidal activity of the chloride of lime solution. The results obtained were always less satisfactory than when the *B. c. c.* alone was present, even in considerable numbers, i.e. when the water contained little organic matter in solution, and when coarse suspended matter had been filtered from the water. Working with pure chalk water in which were but few of the *B. c. c.*, I found that not only this organism but the other

non-spore-bearing organisms were killed off by one part per million of available chlorine.*

Quantity of Broth added per Litre of Water	Quantity of Water Examined	No. of *B. c. c.* added per c.c.	Result of 15 minute Treatment	Proportion Surviving
None	456 c.c.	5–4000 average 678	1 organism survived	1/258,000
0·1 c.c.	108 c.c.	800–4000 average 2450	ditto	1/241,000
0·2 c.c.	128·6 c.c.	150–800	1 in 20 c.c.	1/9,580
0·25 c.c.	257 c.c.	5–400 average 130	depends on No. of organisms in water	1/545
0·3 c.c.	64·3 c.c.	475	1 c.c. contained 7 *B. c. c.*	1/68
0·5 c.c.	43·3 c.c.	4150	*B. c. c.* in 0·1 c.c.	...

FIG. 22.—Summary of Chlorine Sterilization Experiments (1 in 1,000,000) with water experimentally contaminated with *B. coli communis* and dead organic matter, i.e. neutral broth.

Determined to push the matter further, and continuing my experiments, I found that one part of available chlorine in seven million parts of water was sufficient to destroy the small number of non-spore-bearing organisms present in pure chalk water, and I was able to demonstrate both by plate cultivations and by the incubation of large quantities of water, to which McConkey's concentrated bile salts medium was added, that this minute quantity, acting for a period of twenty minutes, was sufficient to eliminate the *B. c. c.* from clear chalk water in which carbon dioxide in an easily separable form was held. In some earlier experiments I had demonstrated that the cholera vibrio and the typhoid bacillus reacted not only to hypochlorous acid but to other antiseptics much as does the *B. c. c.* I felt justified, therefore, in later investigations in concentrating my attention on the *B. c. c.* Having determined how easy a matter it is to kill this micro-organism by weak solutions of chloride of lime, solutions that gave merely a violet end-point, or very faint blue, reaction with starch and iodide of potassium, I found that water so treated and reacting was absolutely tasteless, though impartial observers whom I could persuade to partake of both treated and untreated samples agreed—when they did not

* The available or reacting chlorine is utilized as indicating the amount of hypochlorous acid present, and therefore the oxidising power of the solution.

know which sample they were taking—that one was bright and sparkling in taste, the other insipid, though more frequently than not they hit upon the treated water as being the better sample of the two. I hold, of course, that it is no better, and that when the process is carried out properly no difference can be discerned. In the earlier experiments plates and broth cultures had to be prepared in order that the presence or absence of bacteria in the water, both before and after treatment, could be determined, the bacterioscopic examinations being always supplemented by a chemical test for the presence or absence of available chlorine, and it was noted that whenever the chemical test gave an indication of the presence of the slightest excess of chlorine at the end of twenty minutes, the *B. c. c.* was invariably absent even from such large quantities as five or six samples of 500 c.c. each. It was manifest, therefore, that if, after allowing the chloride of lime solution to act for a period of twenty minutes, there still remained a slight excess of chlorine demonstrable by the iodide of potassium and starch test, the water must be "sterile." These experiments were repeated time after time, always with the same satisfactory results.

—	Amount of Water Tested in McConkey's Medium	Result	1 c.c. into Agar		1 c.c. into Gelatin			
			1 Day	2 Days	Col.	Liq.	Col.	Liq.
Untreated .	60 c.c.	1 acid in 10 c.c.	...	...	8	0	37	7
Treated . .	700 c.c.	all negative	0	0				
Untreated .	170 c.c.	2 acid in 170 c.c.	1	2				
Treated . .	550 c.c.	all negative						
Untreated .	120 c.c.	1 acid in 20 c.c.	...	...	38	1		
Treated . .	1400 c.c.	all negative						
Untreated .	230 c.c.	3 acid, gas, in 230 c.c. 2 gas in 30 c.c.	...	5	32			
Treated . .	2000 c.c.	all negative	0	0	1	0		
Untreated .	170 c.c.	3 acid in 170 c.c.	0	0	5	1		
Treated . .	2000 c.c.	all negative						
Untreated .	100 c.c.	1 acid in 20 c.c.	...	...	3	1		
Treated . .	1500 c.c.	all negative						

Fig. 23.—Result of Bacterioscopic examination of Cambridge U. and T. W. W. Co.'s Fulbourn water before and after treatment with 1 part Chlorine to 7 millions of water.

Treated water thus, "all negative."

Since these earlier observations more exact experiments have been carried out. In these the action of the hypochlorous acid has been cut short by adding sterile thio-sulphate of soda to the

experimental solutions at intervals of from half a minute up to twenty minutes, and it has been found that an enormous amount of work is done in the first half minute, that at the end of five minutes, only the most resistant specimens of the *B. c. c.* remain, and that at the end of ten minutes the whole of them have been killed (see fig. 24). In allowing twenty minutes for the sterilization,

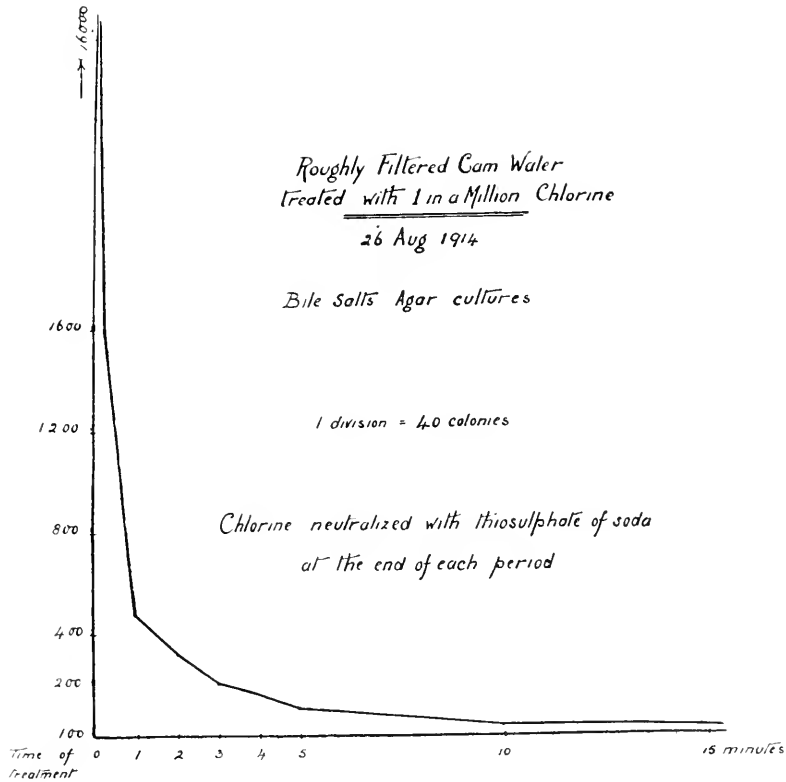

FIG. 24.—Chart giving fall of total number of organisms per c.c. of water from 16,000 to 45. All *B. c. c.* have been eliminated by the "chlorine treatment."

then, it is evident that provision is made for a working margin of ten minutes after sterilization has been completed. It is now recognized that the chloride of lime sterilization process is the result of oxidation, and that not only living bacteria but dead organic matter in solution appropriate the oxygen, some of it very rapidly. Consequently, wherever organic matter is present in water it is necessary to use a larger proportion of the hypochlorite of lime in order to effect complete sterilization (see fig. 22). Should there be

a large quantity of organic matter in the water one might naturally expect that it would inhibit the action of the hypochlorite upon the bacteria. Let us see what happens in water containing this large quantity of organic matter. If sufficient hypochlorite be added to give a very large excess of chlorine at the end of twenty minutes, and samples of this treated water be tested at intervals of three or four hours, it will be found that the whole of the "chlorine" may have disappeared in twenty-four or forty-eight hours, the oxygen being used up as it is set free (nascent) in oxidizing the organic matter. How does this affect the sterilization of the water? It must be remembered that only the very rapidly oxidizable organic substances can play any part in diverting the oxygen from the living bacteria. If the oxygen is not taken up by the organic matter in twenty or even ten minutes it remains available during that period for the destruction of *B. c. c.* or similar organisms, and, as they are attacked and destroyed by it in this time, it follows that an excess of available oxygen and chlorine demonstrable at the end of ten or twenty minutes affords evidence that the "sterilization" of the water is complete. If the whole of the oxygen and chlorine are absorbed before the end of twenty minutes, and certainly if before the end of ten minutes, it matters little whether it has been absorbed by the bacteria or by the organic matter in solution—it has not been allowed to act fully on the whole of the killable organisms, and the more resistant remain capable of development and multiplication, this applying not only to the *B. c. c.*, but also to the typhoid bacillus, the cholera vibrio and the bacillus of dysentery, should any of these be present in the water being treated. Now, gentlemen, you may say, what has all this to do with the micro-biological problems arising out of the present war? My answer is: By Wright's method of inoculation patients are, in a large measure, protected against the activities of the typhoid bacillus, even though this bacillus gain access to the alimentary canal. If, however, it is possible to cut off one of the sources from which the typhoid bacillus may make its way into the alimentary canal then we have provided an additional safeguard against the disease, and have further diminished the possibilities of typhoid infection and have also greatly diminished the possibility of infection of cholera and bacillary dysentery, two diseases against which at present little attempt can be made to protect our troops by inoculation. We must act vigilantly and take strict precautions to keep the water supplied to the troops pure, especially in the hot months of the year, during which outbreaks of most far-reaching and fatal character, the result of infection by cholera vibrio and the dysentery bacillus, may make their appearance.

You may say, of course, that there is nothing new in all

this, and in this I agree, except in so far that here we have a practical method of sterilizing water and determining within twenty minutes whether that water is sterile or not, using the term "sterile" in the sense that indicates that we have cut out the organisms that produce disease, i.e. that it is innocuous. By a simple chemical test it is possible for an advance water-party to decide how much chloride of lime must be added to 100 or 120 gallons of water (the usual capacity of an Army water-cart) to render it innocuous, and then to carry out the treatment so that there may be an ample supply of potable water on the arrival of the troops in camp. All this can be done with no more complicated apparatus than half a dozen reputed pint mugs, a couple of grams of chloride of lime, some boiled starch (or, as was pointed out by my assistant, Mr. Mitchell, to a sanitary officer of high rank who objected that starch was not always available, a bit of boiled potato, a scrap of biscuit, or a little boiled flour, one of which is always at hand), a few crystals of iodide of potassium, which can be carried in a well-corked bottle in a vest pocket, and a lead pencil. I will not trouble you with all the calculations, gentlemen, but the following is the basis on which we work. Two grams of chloride of lime (33 p.c. available chlorine) contains sufficient of the chlorine-oxygen compound to provide rather more than one part of chlorine per million for 120 gallons of water. A reputed pint mug filled to within a quarter of an inch from the top contains 18 oz. or 500 c.cms., and five drops of water dropped from the unsharpened end of a lead pencil weigh 0·3 grm. = 0·3 c.cm. If the test be carried out, as it easily may with this apparatus, and it is found that with one-half part of chlorine added to one million parts of water no blue or purple reaction is obtained on the addition of a crystal of iodide of potassium and sufficient boiled or soluble starch, then it may be accepted that there is not enough of the oxy-chlorine compound present to ensure the destruction of all the above-mentioned organisms present. Even if one or two parts per million be added and no blue colour is obtained, it may again be accepted that a large enough quantity of the sterilizing reagent has not been added, and herein lies the importance of the test. It is only when a "blue" reaction is obtained at the end of twenty minutes that "sterilization" has been effected, and whether the faint purple or blue reaction be obtained with half, one, one-and-a-half, or two parts of chlorine per million of water, that indicates the amount of the oxy-chlorine compound to be added for the sterilization to be complete. If anything more than this faint tinge (i.e. a deeper blue colour) appears at the end of twenty minutes, then too much of the chloride of lime has been added, the water will have an unpleasant taste, and certainly will not quench the thirst as does a properly sterilized water. This question of taste is, of course, of

vital importance, for troops will usually prefer to run the risks attaching to the use of a dangerous water that is bright and sparkling to drinking a sterile water that is flat or otherwise unpalatable. Gentlemen, the culture method supplemented the Microscope in the early days of bacteriology, and now this simple chemical method forms merely an additional supplement; but I believe that as it becomes more widely recognized and its use extended, many of the difficulties hitherto standing in the way of the sterilization of water will gradually disappear, and I am satisfied that for the use of the Army in the field no other method, unless based on the same principle, can, in the present state of our knowledge, supplant it.

During the last month or six weeks the attention of medical men throughout the kingdom has been attracted to happenings on Salisbury Plain, where, amongst the Canadians there encamped, epidemic cerebro-spinal meningitis, one form of the old spotted fever, has made bold to raise its head. Many of us who have had little experience of this disease thought of it as a disease that was not likely to break out in other quarters, though, considering the conditions that exist in various parts of the country, we might well have anticipated that having made its appearance in one spot it was likely, if former experience could give us any lead, to put in an appearance wherever men are crowded together in tents, hutments or billets. There has been an outbreak in Cambridge, an outbreak that will, in due course, be described in full from various points of view and by different workers; but as I have had an opportunity of seeing a number of patients, of following the bacteriological investigations carried out by Dr. L. Cobbett and Captain Gaskell, of examining a number of contacts, and of discussing with Colonel Griffiths, Captain Foster and Lieutenant Fiddian the chemical and biological conditions under which the specific organism causally associated with this disease manages to keep up the continuity of its species, I beg that you will allow me to take these cases as a text on which to base a few remarks, and as affording an opportunity of putting a number of questions, the answers to which I hope will be the outcome of the many investigations into the cause and course of this disease that are now being carried out in various parts of the country. I am afraid that here, again, my remarks may have a somewhat medical flavour, though they refer to something of far wider importance than a merely medical question, and so far, I think, we, as a Microscopical Society, may interest ourselves in it. Epidemic cerebro-spinal meningitis or fever was only differentiated as a separate disease in the first half-dozen years of the nineteenth century. Though more or less sporadic in its incidence, it has every now and again taken the form of distinct epidemics. It was first described as one form of jail or spotted fever, and, for some

time after it had been described as a separate disease, it was often mistaken for the old jail fever, at that time not differentiated into typhus and typhoid. I was much interested to note that Sir William Osler has recorded his conviction that it was an entirely new disease at the time when it was first described, and that it could scarcely have come under the ken of our great English physicians; but, as I had occasion to point out the other evening, although I have the greatest respect for the powers of observation of the physicians of the seventeenth and eighteenth centuries, I think we ought to remember that their opportunities of making careful observations in jails, barracks and ships, where the patients died like flies from jail or typhus fever, must have been extremely limited. It must be recognized that epidemic cerebro-spinal meningitis, if present, would in all probability, under the conditions prevailing in the places where it was most likely to be met with—the foul jails of the pre-Howard days—assume the fulminating type and carry the patients off in a few hours before accurate observations of any kind could be made. I am the more convinced of this when I find that practically the only sign by which it would then be possible to distinguish the epidemic cerebro-spinal meningitis from typhus or typhoid is, according to Sir William Osler, not to be relied upon, for he says *: "Both types of typhoid present symptoms which closely simulate cerebro-spinal meningitis. On several occasions, at the Montreal General Hospital, cases have been sent into the wards with a diagnosis of cerebro-spinal fever. These cases showed high fever, delirium, retraction of the neck" (the distinguishing symptom above referred to), "spasm, and tremor of the muscles, and, had not the post-mortem examination revealed typhoid lesions and only cerebro-spinal congestion, the diagnosis would not have been corrected. I am sure that many cases sent into the Health Officers as cerebro-spinal fever are instances of the cerebro-spinal form of typhoid." Moreover, I cannot but believe that cerebro-spinal fever was present in crowded, badly ventilated, badly sewered jails, barracks, hulks, and even houses, long before it was recognized and differentiated from a group that at that time contained what are now known to be two distinct diseases, typhus and typhoid fevers, and probably the third, epidemic cerebro-spinal meningitis. It is important to remember this, as, from a study of former epidemics and from what I have seen of the disease, it is a condition associated, specially, with the herding together of people in badly ventilated quarters. What are the chief general points of interest of this malady? It appears to be as variable in type as almost any known disease, and in some instances it may be that it assumes such a mild form that it is not recog-

* "Principles and Practice of Medicine," 1st ed., p. 187.

nized. Further, it appears that people may be carriers of the germs, and, therefore, centres of infection, possibly for weeks, and never manifest any specific symptoms, indeed appearing to be in full health. It complicates matters somewhat that the germ producing the disease is, in its microscopic appearance and straining reactions, very similar to some two or three other organisms that are met with in healthy, or inflamed, throats. Weichselbaum, who discovered and first described the meningococcus, as it is called, isolated it from the serus and seropurulent fluid drawn, by tapping, from the cerebro-spinal canal of a patient suffering from what was spoken of as "spotted" fever or cerebro-spinal meningitis or cerebro-spinal fever. He found the organism, to which he gave the name, *Diplococcus intracellularis meningitidis*, not only lodged in the pus cells separating out in the sediment of the fluid when allowed to stand or centrifugalized, but also lying free between the cells. The meningococcus, "for short," is readily stained by the basic aniline dyes, and is Gram-negative, in this, however, as noted above, resembling at least two other diplococci. It grows best at the temperature of the body, and, except under very favourable conditions and in specially good nutrient media, its growth is checked completely when the organism is exposed to a temperature below 23° C. As taken from the spinal canal the organism seems to be strongly parasitic, and does not grow at all readily on ordinary nutrient media, and only sparsely on special media. It may be, of course, that many of those seen under the Microscope are dead, and as a matter of fact many of them stain very imperfectly (this lending support to the view that their life is a brief one, and that they do not multiply, except under very favourable conditions), for even when the number of diplococci seen under the Microscope is large, the number of colonies growing, on the most suitable medium, is comparatively small. The most suitable medium for its growth is said to be agar containing a small amount of nutrose and human serum or ascitic fluid, but all my experience has been with nutrient agar, to each tube of which a few drops of human or rabbit blood are added just before it consolidates. This is certainly an excellent medium, the hæmoglobin supplying something exceedingly favourable (perhaps too favourable for our purpose) to the growth of the organism. With the permission of my colleague, Captain Gaskell, I show a drawing made from preparations in which the meningococcus is seen lying in and around the pus cells. Here the shape of the organism and the marked lack of staining power of some of the diplococci is evident. The organism, which measures 1 μ or slightly more in diameter, usually occurs in pairs of flattened slightly kidney-shaped bodies with their concave surfaces facing each other, and with a small clear band or space between. Sometimes a single coccus may be seen, whilst again tetrads or groups of four may be met with. It

does not appear to form chains as does the pneumococcus. It is said that when this organism is grown on blood agar it may be surrounded by a capsule similar to that met with in the pneumococcus passed through the blood of a living mouse. I have succeeded in isolating such an encapsuled organism from the

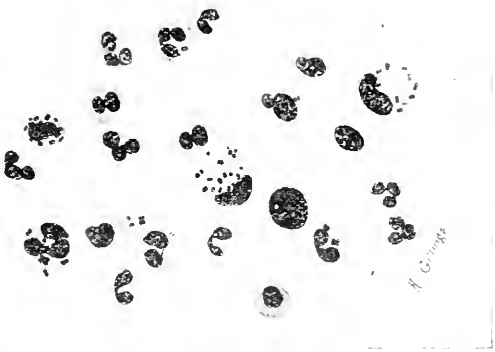

FIG. 25.—*Diplococcus intracellularis meningitidis* of Weichselbaum lying in and between the cells in the fluid withdrawn by lumbar puncture from a case of cerebro-spinal fever. Drawing × 800 from a specimen prepared by Captain J. F. Gaskell, M.D., R.A.M.C., T.

throats of "contact" cases, an organism that has many of the characters of the meningococcus. Successful cultures of this coccus from the cerebro-spinal fluid are fairly characteristic in appearance. They occur as moist, smooth, rapidly growing colonies, making their appearance in ten or twelve hours, and extending rapidly to form somewhat thick, greyish colonies, opaque in the centre, but with a more translucent zone at the periphery, the margin being smooth, regular, and fairly sharply defined. Secondary cultures made from these colonies grow profusely, often running together and forming a moist, grey, almost slimy-looking mass. This organism, grown on media containing maltose, glucose, or galactose, especially the first of these, and some indicator, of which neutral red appears to be the most satisfactory, is found to produce acid, and it is by this production of acid from these sugars that it is said to be distinguished from the *Micrococcus catarrhalis*, one of the Gram-negative diplococci for which it may be mistaken under the Microscope. There is, however, this further difference, that the *Micrococcus catarrhalis* grows freely at the temperature of 22° C. or 23° C., a temperature said to be unfavourable to the growth of the

meningococcus. Gordon draws special attention to this feature, and it seems to be one of considerable value in the process of differentiation, though if the medium be "too rich" or too stimulating, this failure of the organism to grow at the lower temperature is not always observed.* The imperfect staining of many of the meningococci, though already referred to, may again be mentioned in connexion with a very curious feature present in forty-eight-hour cultures taken from the throats of contacts, i.e. individuals who have slept near and breathed the atmosphere in a close and crowded hut where a virulent case of the cerebro-spinal meningitis has occurred. In stained preparations made from colonies resembling the typical colonies derived from cultures from cerebro-spinal fluid, whether basic dyes or Gram's method be used, an enormous number of diplococci remain practically unstained, and I think it is possible, though as yet I have not collected sufficient evidence on this point, that this feature may help in deciding whether we are dealing with the meningococcus or not. It is recognized that it is necessary to subculture the meningococcus every two or three days, or better still every twenty-four hours, at any rate until it has had time to assume saprophytic characters, when, according to Weichselbaum's pupils, the organism may remain alive and active for months. Of that, again, I have as yet had no experience, but I have had too much experience of the readiness with which it dies out under unfavourable conditions. This delicacy has to be borne in mind when we come to consider some of the problems still to be solved in regard to cerebro-spinal meningitis. Speaking of the conditions under which this disease occurs, I have already expressed the opinion that epidemic cerebro-spinal meningitis occurs only where there are overcrowding and bad ventilation, the bad ventilation being, I believe, an even more important determining factor than the overcrowding. We realize that epidemic cerebro-spinal meningitis is no longer a jail fever, in civilized countries at any rate, as most of the jails to-day are as well (or better) ventilated, as are most

* Since the above was written, and with wider experience of cultures of the meningococcus in different media, I have satisfied myself that Gordon is correct in his contention that a special medium must be used if this temperature test is to be relied upon, as the meningococcus cultivated on a medium too rich or stimulating will, in many instances, grow at a temperature of 22° C. or 23° C., when the same organism seeded on nutrose ascitic agar, though growing at 37° C., fails to multiply at 22° C. or 23° C. Here, too, I must refer to Dr. R. M. Buchanan's paper on the differentiation of the meningococcus from other Gram-negative diplococci that are met with in the nasopharynx of cerebro-spinal fever contacts (Lancet, 1907, i. p. 1590), a paper that I had overlooked when the above was written. It is certainly one of the most useful contributions to this subject that has been made, and had I known of its existence, which I ought to have done, it would have saved me a considerable amount of experimental work on reactions of the meningococcus in media containing sugars, with neutral red as an indicator.

modern dwelling-houses; it is now essentially a disease of barracks, ships and huts, and not of the open camp, though in bad weather, *and in good tents,* the conditions for its development even under canvas may not be wanting. Those who have had longest experience of barrack life, and have profited by it, invariably associate streptococcal sore throat with bad ventilation, for, although you usually find little or no throat mischief in well-ventilated huts, sore throats and catarrh abound in all those that are badly ventilated, and I am satisfied that where throat mischief abounds cerebro-spinal meningitis can gain a footing. Those who have studied the history of epidemics of cerebro-spinal fever find that it usually occurs in the late winter and the early spring, the periods when men, to escape the cold, shut out fresh air, when catarrh and throat mischief become rife and the protecting mucous membrane of the upper part of the respiratory tract is damaged, and when, especially after long-continued periods of wet and cold, vitality is depressed, and the resisting power of the organism is below par. I have long been satisfied that, especially in young people, there is a close connexion between the tonsils, the lymphatic tissue of the upper part of the naso-pharynx, and the large lymph spaces near the base of the brain, and I believe that the healthy lymphoid tissue in these positions acts as a filter and prevents the invasion of the cerebro-spinal lymphatics by various pathogenetic micro-organisms. When, however, such defences are weakened or broken down, the organisms accumulating in large numbers in the upper and posterior nares and fauces may "break bounds" as it were and make their way by the finer lymphatics into the cerebro-spinal spaces, and this whether the organism be the tubercle bacillus, the meningococcus, a streptococcus or the pneumococcus. Whether it be a lymphatic invasion alone or whether it be lymphatic in the first instance, but followed by an invasion of the blood vessels, I am not in a position to offer any definite opinion, but that in its milder form it presents but slight evidence of a hæmal infection, whilst in the more severe cases it is distinctly septicæmic in character, appears to be beyond doubt. It is evident that the patient who has been a carrier for some time may be attacked after his resisting powers have become impaired, as he develops an attack of catarrh, is chilled and depressed by a spell of cold weather, or as he is exhausted by want of food, by over-exertion, by the lack of sleep or by an attack of some minor ailment or secondary disease. The one great comfort we have in all this is that the organism appears to be an exceedingly delicate one, and that only under specially favourable conditions is it capable of remaining alive for any length of time. It is stated that a healthy individual may be a carrier for a fortnight or three weeks, and that cases are recorded (though owing to the difficulty of identifying the diplococcus doubt may

be thrown on these observations) of its persistence in the throat of a carrier for two or three months or more. Under these conditions, may not the individual acquire an immunity against its attacks? It is obvious that this is only one among the many questions that remain to be settled concerning this disease, and although it is most devoutly to be hoped that the opportunities for study will not be too prolonged, we should make the most of those we have, realizing in the meantime that the chances of infection are greatest directly from patient to patient, that it is a contagious rather than an infectious disease, and that the closer the contact and the worse the conditions of ventilation the more likely is the disease to be handed on from patient to patient or from patient to contact and contact to patient. In the only real epidemic that I have had the opportunity of following not more than a single patient has appeared in any one of forty-five huts, and the most severe, in fact the only fatal case, of five was the last, and I hope the final case, as since effective ventilation of the huts has been maintained there has been no further case, and I shall be greatly surprised and disappointed—if the ventilation be maintained—if another makes its appearance.

V.—*A Simple Form of Spectroscope and Micro-spectroscope.*

By Julius Rheinberg.

(*Read April* 21, 1915.)

(Figs. 26-28.)

In many of the scientific or commercial purposes in which spectroscopic examinations are necessary or convenient, exact measurements are not required; it suffices to examine the general character and positions of the transmission and absorption bands, and it is usually desirable to examine and compare several specimens at the same time. As a typical instance I may mention the examination

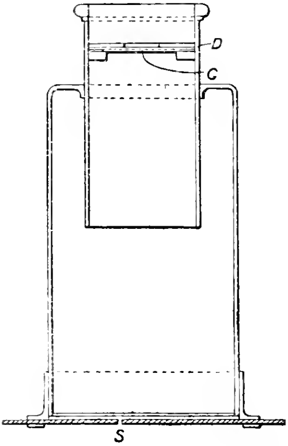

Fig. 26.—D, diaphragm; G, grating; S, slit.

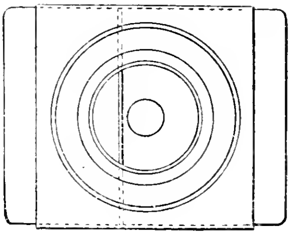

Fig. 27.

of coloured solutions and dyed films for photographic filters or for use in microscopy.

For such purposes I have since many years used the above exceedingly simple form of spectroscope, which not only costs next to nothing, but has several very decided advantages over the ordinary expensive and more or less complicated instruments usually used for spectroscopic examination.

The spectroscope consists of a tin or cardboard tube of 3-in. diameter, blackened inside, with an adjustable slit at its lower end made of two pieces of metal sheet sliding in a groove. In the upper end of this tube, a narrower tube, blackened inside, is fixed.

Near the top of this, a small piece, $\frac{1}{2}$ in. square, of a Thorp diffraction grating film of 14,000 lines per inch, is fixed between two pieces of glass covered with a black cardboard diaphragm having a hole of $\frac{3}{8}$-in. diameter. The distance between the grating at the upper end and the slit at the lower end is 8 to 10 in., or, if desired, the tubes may be made to slide so that the distance can be varied. This constitutes the whole instrument; it will be observed that no lenses are employed at all.

To use the spectroscope to compare strips of coloured film, for example, the latter are kept close to the slit with a couple of elastic bands, and on looking through the grating at the eye end of the instrument, the actual colours of the films are seen behind the slit, flanked on each side by spectra of the colours in question.

As it is only needful to view one of these sets of spectra (the other being superfluous), it is convenient to keep the slit near the right side of the object end of the tube. The left-hand set of spectra can then be viewed comfortably without any eye-strain, whilst the right-hand spectra move outside the field of vision. Nearly all gratings yield a better and brighter spectrum on one side than the other; the grating should therefore be turned round so that its best spectrum appears on the left-hand side.

To view dye solutions in test-tubes, it is of course only necessary to hold the spectroscope so that the slit lies horizontally; the spectra are then viewed below the slit.

The two special advantages of the instrument, apart from its simplicity and inexpensiveness, are:—

1. That as many as half a dozen different spectra can be viewed and compared at the same time, together with white light.

2. That the colours of the objects themselves are seen at the same time as well as their spectra.

I do not know of any other form of spectroscope which possesses these conveniences, and can testify to the utility and efficiency of the little apparatus in question from frequent use during a number of years.

Recently, in the course of some research work, it has been necessary for me to examine and compare the spectra of the colours of the microscopic colour-lines and dots of multicolour screen-plates used for colour-photography, and for this purpose of course the apparatus described above is unsuited. It therefore seemed desirable to devise some form of micro-spectroscope possessing the same advantages, and the following extremely simple form, which anyone can fix up for himself in a few moments, is the outcome.

An ordinary low-power eye-piece is taken, and in the plane of the diaphragm a stop is inserted with a slit about 1 mm. width, taking care that the slit is near the right-hand side of the circular hole of the diaphragm. A small piece of Thorpe grating film,

14,000 lines per inch, is then placed between two micro-cover-glasses, these being placed immediately over the eye-lens, the cap of the eye-piece serving to keep them in position. That completes the micro-spectroscope.

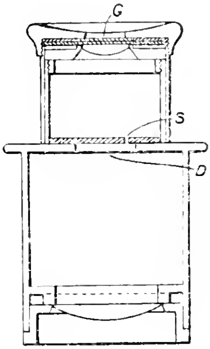

FIG. 28.—D, diaphragm ; G, grating ; S, slit.

The parts of the object to be examined are moved on the object-stage so that their image falls on the slit in the eye-piece diaphragm. They are then seen in the Microscope with their spectra next to them, exactly as in the case of the hand apparatus above described.

Although unnecessary for the purpose for which I have been using the micro-spectroscope, it would seem best for general purposes to arrange for the one jaw of the slit to be removable, or, rather, to be able to pull it out of the field of view, or push it up to the other one through an opening in the eye-piece tube. In this way a large part of the object specimen will be in full view, and the part to be spectroscopically examined can be conveniently moved to the position of the slit before closing in the other jaw.

A very convenient plan would be to have an entirely removable slit, which could be inserted through an opening in the eye-piece tube, the slit having one sliding jaw which could be adjusted as indicated, and also to have the diffraction grating fixed in a small plate, which can be inserted and slid into position through openings in the eye-piece cap. In this way the eye-piece would be free for its usual purpose entirely unspoiled, whilst it could be set up and used as a micro-spectroscope at a moment's notice.

I imagine that such a micro-spectroscope would be found useful for a good many purposes, and do not know that a form having the advantages mentioned has been suggested previously elsewhere. If it has, no doubt it will be pointed out, and my apology then for bringing the matter before you will be that so simple a form of apparatus deserves to be more generally known.

OBJECTIVE SCREW THREAD.

(FIG. 29.)

THE question of standardization of the Objective Screw Thread was first discussed by the Microscopical Society in 1857,* and the first sizing tools were issued in 1858.

In 1896† the Council of the Royal Microscopical Society issued another Report, and drew up a specification defining the limits of variation allowable from the original standard screw thread.

Difficulties having arisen in connexion with the testing and adjusting of the sizing tools supplied by the Society,‡ the Council in 1911 appointed a Gauges Committee to look into the question of obtaining and testing further tools, and they now have pleasure in informing Fellows of the Society that an arrangement has been made with the Director of the National Physical Laboratory whereby the standard gauges of the Society have been deposited at the National Physical Laboratory. The Council has also arranged for the issue of new objective screw sizing taps and dies, which have been tested and passed by the N.P.L., and are within the following limits :—

Tap for sizing Nose-pieces: full diameter between 0·800 in. (= 20·3198 mm.) and 0·803 in. (= 20·3960 mm.).

Die for sizing Objective : core diameter of thread between 0·7596 in. (=19·2937 mm.) and 0·7626 in. (=19·3699 mm.).

A certificate of accuracy is issued with each tap and die. These sizing tools are now on sale, and may be obtained by application to the Secretaries of the Royal Microscopical Society.

The standard specification for the objective thread has not been altered, and is as follows :—

SPECIFICATION OF THE ROYAL MICROSCOPICAL SOCIETY STANDARD SCREW THREAD FOR OBJECTIVES.

Metrical Measurements in Brackets.

Diameter.—0·800 in.

Pitch.—36 to the inch.

Form.—Whitworth screw, i.e. a V-shaped thread, sides of thread inclined at an angle of 55° to each other, one-sixth of the V depth being rounded off at the top and the bottom of the thread.

* Trans. of the Microscopical Society, 1858, p. 39; 1859, p. 92.

† Trans. of the Royal Microscopical Society, 1896, pp. 389, 487.

‡ In this connexion the paper published in the Trans. R.M.S., 1911, p. 175, is interesting.

Length of Thread on Objective, 0·125 in. (= 3·1750 mm.).

Plain Fitting above Thread of Objective, 0·1 in. (= 2·5400 mm.) long, not to exceed 0·759 in. (= 19·2784 mm.) in diameter.

Length of Screw of Nose-piece to be not less than 0·125 in. (= 3·1750 mm.).

Limits.

Nose-piece :—

Core Diameter of Thread (A) not to exceed 0·7674 in. (= 19·4918 mm.), or be less than 0·7644 in. (= 19·4156 mm.).

Full Diameter of Thread (B) not to exceed 0·803 in. (= 20·3960 mm.), or be less than 0·800 in. (= 20·3198 mm.).

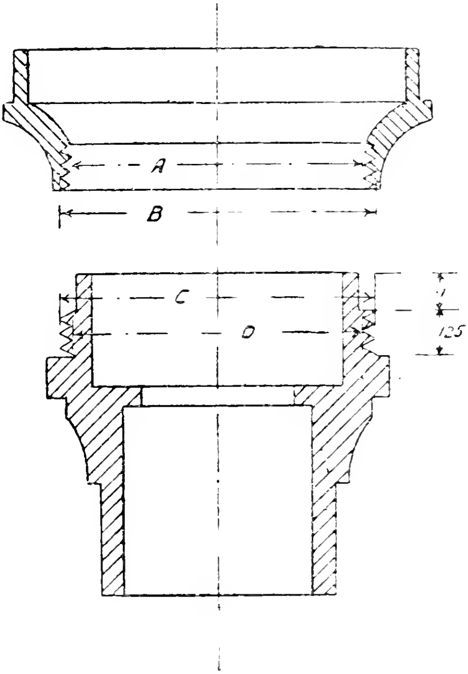

Fig. 29.

Objective :—

Full Diameter of Thread (C) at top of thread not to exceed 0·7982 in. (= 20·2741 mm.), or to be less than 0·7952 in. (20·1979 mm.).

Core Diameter of Thread (D) at bottom of thread not to exceed 0·7626 in. (= 19·3699 mm.), or to be less than 0·7596 in. (= 19·2937 mm.).

SUMMARY OF CURRENT RESEARCHES

RELATING TO

ZOOLOGY AND BOTANY

(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),

MICROSCOPY, ETC.*

ZOOLOGY.

VERTEBRATA.

a. Embryology.†

Artificial Parthenogenesis and Fertilization.‡—Jacques Loeb has given a connected account of his experiments on the substitution of physico-chemical agencies for the mysterious complex "living spermatozoon." He adheres to his previously stated theory that two factors are involved in what the spermatozoon effects—there is a change in the surface of the egg, and there is a corrective factor.

The unfertilized egg-cell dies a natural death; the act of fertilization will prevent this. The rôle of the spermatozoon as a bearer of hereditary qualities is to be distinguished from its developmental rôle. The two effects probably depend upon different materials in the spermatozoon. Development may occur if a spermatozoon enters a de-nucleated ovum; therefore, fusion of nuclei is not essential. Boveri's view that the unfertilized egg-cell lacks the centrosome, which is the organ of cell division, is disproved by the fact that astrospheres are formed in unfertilized ova treated with hypertonic solutions. The maturation of the ova of *Chætopterus* does not normally occur unless the spermatozoon enters: centrosomes and astrospheres are present in the maturation division. But it may occur if some potassium be added to the sea-water. Hence the effect of the spermatozoon in this case is not due to the introduction of a centrosome into the egg.

Unfertilized sea-urchin eggs will develop into larvæ if exposed for a

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, etc., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, Reproduction, and allied subjects.

‡ Artificial Parthenogenesis and Fertilization. University of Chicago, 1913, pp. 1-312.

couple of hours to hypertonic sea-water, i.e. sea-water to which had been added sufficient salt and sugar to raise its concentration about 60 p.c. The developmental effect of the hypertonic solution increases with the concentration of the hydroxyl-ions. Unfertilized eggs of *Chætopterus* developed into larvæ when Loeb added potassium and acids to the sea-water, without it being necessary to increase the osmotic pressure. Unfertilized eggs of starfish were made to develop by means of acids.

When a spermatozoon enters an egg, a fertilization membrane is formed. In 1905 Loeb discovered that a short exposure of the sea-urchin egg to a monobasic fatty acid, or to CO_2, led to the formation of a typical fertilization membrane, and that a subsequent short exposure to hypertonic sea-water resulted in development. Membrane formation alone leads to segmentation, but disintegration may set in. The hypertonic solution, with sufficient free oxygen, counteracts this. Another counteractive was found in arresting development for two or three hours, e.g. by putting the eggs in water without oxygen. Membrane formation is the essential step in the activation of development, and sometimes it is followed by normal larvæ.

A short exposure to cytolytic agents (such as saponin, solanin and digitalin) induces membrane formation. In the case of *Polynoe* this induces development of larvæ; in the case of *Strongylocentrotus* the eggs must be subsequently exposed to hypertonic sea-water in order to counteract the injurious secondary effects of membrane formation. Raising the temperature may suffice to induce membrane formation. Some eggs which are permeable to the "lysins" of foreign blood form membranes and develop into larvæ. The eggs of a marine mollusc, *Cumingia*, sensitized with a solution of $SrCl_2$, can be caused to develop into larvæ if treated with ox blood or serum. Extract of foreign cells will also induce development.

The spermatozoon seems to carry a cytolytic substance or "lysin," which induces membrane formation, and another substance which prevents disintegration. It may be that the slight parthenogenetic tendency exhibited by many eggs depends upon the slight stability of the emulsion at the surface of the eggs. It may be that the cytolytic agents destroy the stability of the superficial emulsion.

The artificial membrane formation may induce development by accelerating oxidations. The entrance of the spermatozoon raises the rate of oxidations from four to six times the usual amount. This may be due to an oxidase, or more probably to the change in the surface layer. The entrance of two spermatozoa does not increase the rate of segmentation.

To preserve the life of the egg-cell in artificial parthenogenesis both the membrane-forming factor and the corrective factor are necessary. The oxidations going on in the mature but unfertilized egg are one of the causes leading directly or indirectly to its death. It appears as if the process of fertilization rendered the egg immune against oxidations, or, in other words, transformed the egg from an anaerobe into an aerobe.

Larvæ reared from artificially parthenogenetic ova may be normal and apparently healthy. Delage reared two sea-urchin larvæ during sixteen months to the stage of sexual maturity. Both were males. Loeb and

Bancroft raised a tadpole through metamorphosis, and found ova in the gonads.

In the chapter on early stages in development, the author outlines the view that the formation of soap-like substances induces streaming phenomena which lead to cleavage. It may be that a positive chemotropism of the blastomeres toward oxygen leads to the formation of the blastula. It is noted that it has not been proved for animals that the spermatozoon is chemotactically attracted to the ovum. In the chapter on fertilization and oxidation it is noted that oxygen is necessary for nuclear or cell division, including maturation of the ovum and the germination of seeds. The entrance of the spermatozoon accelerates the processes of oxidation and other reactions, e.g. hydrolyses, which can proceed independently of oxidations.

In succeeding chapters the author discusses early observations on natural parthenogenesis in insects, the history of the earlier experiments on artificial parthenogenesis, the methods of artificial parthenogenesis, the effect of artificial membrane formation, the action of the hypertonic solution after membrane formation, the fertilizing effect of foreign blood and foreign cell extracts, the action of the spermatozoon, artificial parthenogenesis and heredity, and similar subjects.

The last question discussed is whether an embryo can develop from a spermatozoon. J. de Meyer placed the spermatozoa of *Echinus microtuberculatus* in sea-water containing an extract of the eggs of the same species and found that they swelled up. Loeb and Bancroft put the spermatozoa of the fowl in nutritive media and saw the formation of a vesicle around the head of the spermatozoon. In yolk and white of egg the spermatozoon seems to undergo transformation into a nucleus, but no mitoses or aster formation was observed.

Chemistry of Development.*—R. A. Gortner has made comparative analyses of the eggs and the newly hatched larvæ of the giant salamander, *Cryptobranchus alleganiensis*. The total dry weight diminishes by 1·6 p.c., due to loss of carbon-dioxide and water, for the total nitrogen does not change. There is a gain of fats to the extent of 14 p.c. over that in the egg. The greatest loss is from the protein fraction, some of which has gone into the fat.

There is considerable evidence that the nitrogen ratios in the protein fraction are not fixed quantities, but that some amino-acids are more necessary than others for the developing embryos. There is probably a continuous breaking down and recombining of the resulting radicals into new compounds.

It seems probable that there is, in the eggs of *Cryptobranchus*, a carbohydrate nucleus, either free (glycogen) or combined in the form of a glycoprotein, and that during the process of embryonic growth this carbohydrate is broken down to carbon-dioxide and water, with a consequent liberation of energy for the work of development. But the breaking down of the carbohydrate proceeds more rapidly than the needs of growth demand, with the result that the surplus energy is stored as fat.

* Year-book. Carnegie Inst. Washington, xiii. (1914) pp. 122–3.

Centrifuging Eggs of Wood Frog.* — A. M. Banta and R. A. Gortner have "centrifuged" embryos of *Rana sylvatica* at the blastopore stage, subjecting them to 1350 times the pressure of gravity for two minutes. All the survivors show an accessory tail-like appendage or several (2–4) accessory tails. These occurred along the mid-ventral region and had a typical tail-like structure. In some "centrifuged" eggs of *Amblystoma*, the front end of the head of the larva, sometimes back as far as the gill, failed to develop. The hereditary determiners for development work out their destined end only when maintained in certain appropriate spatial relations.

Typical Sex-ensemble in Mammals.† — D. Berry Hart uses the term sex-ensemble for the gonads, the urinogenital tract, the opposite sex-duct elements, and the secondary sexual characters. The whole tract is like clearly written manuscript with a palimpsest portion partially erased. The non-potent part in the female includes the epoöphoron and paroöphoron; in the male, the hydatid testis and prostatic utricle.

The germ-cells (or "heredity cells" of the author) arise from the zygote at an early stage, and are intruded into the somatic part of the sex-gland. It is supposed that they are of two kinds, one set with Wolffian determinants, one without. It is supposed that sex is determined at fertilization: a Wolffian spermatozoon and a non-Wolffian ovum resulting in a male-producing zygote, a non-Wolffian spermatozoon and a Wolffian ovum resulting in a female-producing zygote.

The development of the female genital organs may be thus summarized:—

Organs.	Source.
Heredity cells	Early division of zygote.
Somatic part of ovary . .	Genital ridge and connective-tissue of Wolffian body.
Fallopian tubes, uterus, and vagina (upper two-thirds).	Müllerian ducts.
Lower third of vagina . .	Upper part of urinogenital sinus and lower ends of Wolffian ducts.
Hymen	An organ of the urinogenital sinus, and derived from the Wolffian ducts.
Vestibule	Lower part of urinogenital sinus.
External genitals . . .	External region on and below pubes (imperfectly worked out).
Bladder	Anterior division of endodermal cloaca; fundus allantoic.
Urethra	Upper part from the urinogenital sinus, also lower part, but it is re-tunnelled.
Ureter	Upward growth from Wolffian duct.
Kidney	Upward growth, in great part from Wolffian duct; an upper part from Wolffian body.

* Year-Book, Carnegie Inst. Washington, xiii. (1914) p. 122.
† Edinburgh Med. Journ., July and Aug. 1914, pp. 1–47 (5 pls.).

In the male the scrotum is the equivalent of the labia majora, and the closed urethra is represented by the labia minora and urethra of the female. Attached to the testes is the hydatid testis, the rudimentary representative of part of the opposite sex-duct element, the fimbriated end of the Fallopian tube. The testis develops its framework on the genital ridge of the Wolffian body, utilizes parts of the ducts for its tubular portion, taking the Wolffian duct proper for its vas deferens.

The most pronounced differences between the sexes in man are:— 1. The pelvic position of the ovaries, the testes being extra-abdominal and in the scrotum. 2. The fully developed and permanent round ligaments and ovarian ligaments, represented in the male fœtus in the earlier months by the transient stages of the gubernaculum and testicular caudal ligament. 3. A split condition of the labia majora and minora, comparable with the early stages in the male, leading up to the formation of the scrotum, the closure of the spongiosum, and the formation of the urethra. 4. A loss in the female of the middle segments of the Wolffian duct and of the greater part of the Wolffian body, but retention of a part of it as epoöphoron and paroöphoron, as well as of the lower ends of the Wolffian ducts, to form the hymen.

The next step in the author's argument is to show that the genital tract is "segmental," or made up of separable items which may be awanting individually. These correspond to unit characters or groups of unit characters. Thus the male system consists of kidney, ureter, epididymis, vas deferens, vesiculæ seminales, and gubernaculum testis, with hydatid testis and prostatic utricle as non-potent elements.

In the typical human female genital tract there may be forty possible "segments," and four non-potent. In the male there may be twenty-seven potent, and six non-potent. These conclusions are based on the study of exact losses in atypical urogenital tracts.

"The human potent genital-duct tract and the opposite sex-duct elements, constituting with other structures the typical sex-ensemble, have a maximum-minimum, i.e. probability relation, due to successive polar-body losses of the autonomous determinants causal to adult results at maturation, and are recorded in the germ-plasm."

Mendel's unit characters are causally represented in the germ-cells and their derivatives by Weismann's determinants. They are distributed in a probability ratio, and discontinuous variation is due to losses in polar-body formation. In a sex-ensemble there is a maximum of the duct-segment characteristic of the sex, and a minimum of those of the opposite sex-duct element. Weismann's determinants are regarded as molecules and ions, the former of which may be neutral when quiescent, the latter positive or negative during mitosis and maturation. In mitosis there is a temporary persistence of negative and positive ions; in polar-body formation there is an ejection of ions. The former gives rise to continuous variations, the latter to discontinuous variations or mutations.

Inhibition of Pigment.*—A. M. Banta corroborates previous work (on *Spelerpes*), showing that phenols prevent the formation of black

* Year-book, Carnegie Inst. Washington, xiii. (1914) pp. 123–5.

pigment. He has worked with the young larvæ of the giant salamander, *Cryptobranchus*, and finds that if small quantities of phenols are introduced into the tissues of the developing larvæ before pigmentation begins, the onset of pigmentation is markedly postponed and the pigment produced is much reduced in amount. They act by inhibiting the oxidation of tyrosin—a process which forms black pigment. The larvæ do not survive beyond the stage when the stored food in the egg is all utilized, so it is not known how long the modifications would last. Banta also found that amphibian larvæ reared in a cave have little pigment until the period of transformation approaches, when a normal quantity develops. In the Amphipod *Eucrangonyx gracilis* the forms reared in a cave have much less than the normal quantity of pigment. They are less reactive to photic stimulation, and more reactive to tactile stimulation than their relatives in the open.

Hermaphroditism and Pseudo-Hermaphroditism in Mammals.* D. Berry Hart points out that the occurrence of ova and spermatozoa in a common sex-gland has not been proved in Mammals, and that we cannot have a pseudo form of a non-existent condition. It would be better to speak of atypical sex-ensembles. The atypical female sex-ensembles is thus characterized: Sex-glands female; opposite sex-duct elements in varying amount, but not in minimum of the typical sex-ensemble; potent segments present, but not in the maximum of the typical sex-ensemble; secondary sexual characteristics in some degree non-congruent. The atypical male sex-ensemble is thus characterized: Sex-glands, testes, undescended or descended; opposite sex-duct elements in varying states of representation, but not at the minimum of the typical sex-ensemble; potent sex-duct elements diminished, and not at the maximum of the typical male sex-ensemble; secondary sexual characteristics non-congruent.

The proportions are disturbed in atypical cases. In atypical female cases a prostate with lateral lobes only, or with all the lobes, may be present; the suprarenals are enlarged. In atypical male cases part of the lower urinogenital sinus may be present (simulating a vagina and a hymen), the testes may be pelvic, and so on.

In essence, such cases have this sequence developmentally—(*a*) loss of parental determinants of the sex-ensemble at maturation; (*b*) the subsequent formation of sex-ensemble molecules with this loss when the determinants are distributed in the germ-cells and somatic cells; (*c*) in such cases the sex-gland will have normal sex-ensemble molecules and others unduly reduced. The latter will give rise to atypical male or female sex-ensemble in progeny; (*d*) this can be distributed again by such progeny to their offspring.

In diagnosis the whole sex-ensemble must be taken into account: above all that of the sex-gland when accessible. No diagnosis can be based on one organ of the sex-ensemble, e.g. on the presence of a prostate, hymen, apparent vagina, condition of larynx, or psycho-sexual feelings. An apparent vagina with labia means male sex-ensemble; in the atypical

* Edinburgh Med. Journ., Oct. 1914, pp. 1–24 (4 pls. and 1 fig.).

female sex-ensemble there is no external vaginal entrance, as it ends in the prostatic sinus.

Hunter's Freemartin and Reversion.*—D. Berry Hart describes a freemartin which resembled the wild park cattle in having a white hide, black muzzle, black hoofs, blackish spots on the legs, and great timidity. The mother was a normal shorthorn; the co-twin a normal bull. A typical Hunter's freemartin is a sterile, genitally malformed bull, with small undescended testes and rudimentary epididymes, vasa deferentia, and Müllerian elements. Vesiculæ seminales are present. The external genitals consists of labia majora, clitoris, and the urinogenital sinus element (one inch in length) of the vagina.

The potent bull-calf and the freemartin are produced from one fertilized ovum, but the freemartin has allotted to it the hydatid testis and prostatic utricle normally given to the single bull. This produces an exaggerated simulacrum of the female genital tract.

The thyroid, thymus, and suprarenals were found to be normal. The internal genitalia showed fatty degeneration, and were represented only by the urinogenital sinus and the epididymes. The skull was normal. The chief point of interest was the (ectodermic) reversion to the wild park cattle type. A theoretical interpretation is given of the way in which this reversion might come about—by retention of certain ancestral chromosomes normally lost in polar-body formation.

Sex in Pigeons.†—O. Riddle finds that eggs destined to produce males are smaller, and have higher water-content and smaller energy-content, than those that produce females. Whether the difference in energy-content (estimated by the use of the bomb calorimeter) is the cause of the difference in the eventual sex, or whether it is induced by a difference in the unfertilized eggs which determines the difference in storage metabolism is uncertain.

There is reason to believe that there are two kinds of ova, and that those destined to produce males contain a sex-chromosome which the others lack. It may be that the difference in chromosomal content may be the cause of the difference of energy-content.

When the female pigeon is subjected to alcohol vapour, it lays eggs smaller than the normal. Phloridzin and urotropin reduce the fertility of the egg.

Whitman found that if certain somewhat distantly related species of pigeons be crossed and their eggs be removed as fast as laid, so as to induce the pair to continue to lay fertile eggs, then in spring both eggs of a clutch will produce males nearly always or quite exclusively; the last eggs in autumn will produce females nearly always or quite exclusively; while in the transition period the first egg of the clutch usually produces a male and the second a female. It may be that the experience induced a change in the sex-fate of the eggs, or it may be that the distribution of the male and female egg in the ovary is such

* Edinburgh Med. Journ., March, 1915, pp. 1–7 (1 pl.).
† Year-book, Carnegie Inst. Washington, xiii. (1914) pp. 117–19.

that the result observed necessarily follows from the forced heavy reproduction of the mother. Further experiments are necessary.

When two full sisters from the series indicated are hatched from the two eggs of a clutch, one of them behaves in a masculine manner. Females hatched early in the season (when most males are produced) are more masculine than their sisters hatched late in the season. Riddle finds that if extracts from the ovary of a pigeon be injected into those masculine females, they come to behave like females. Contrariwise, if testicular extract be injected into those females that are acting like females they come to act like males. The sex-behaviour of a bird is probably determined by internal secretions from its sex-glands carried to its central nervous system. It may be that the injected extract is different from and superior to that naturally produced.

Secondary Sex-characters in Fowls.*—A. Pézard has found that when the ovary is removed from hens, spurs grow as in cocks. It appears that the ovary has an inhibiting influence on the growth of spurs. The growth that occurs after the removal of the ovary is continuous and regular, and its rate is as in cocks. The same is true of plumage, the hen puts on that of the cock. Pézard concludes that plumage and spurs are not strictly masculine characters like the comb and the crowing. The development and turgescence of the comb in cocks are conditioned by the internal secretion of the testes, but the spurs and plumage are not. They are present potentially in the hens, but are inhibited by the presence of the ovary. The capon and the castrated hen may be almost undistinguishable. They approximate to a neuter ancestral type without sex-dimorphism. From this the normal cock and hen have been derived by addition and subtraction under the control of the secretion of the gonads.

Experiments on Oviduct of Fowl.†—Raymond Pearl and Maynie R. Curtis have made numerous experiments which throw light on the physiology of the oviduct of the fowl. Neither the ligaturing, section, nor entire removal of the oviduct causes degeneration of the ovary or prevents its further growth. The pressure of the enclosing funnel is evidently not necessary to ovulation, for yolks are ovulated into the body cavity after the ostium is sewed or ligatured, or after the entire duct is removed. Internal pressure due to continued yolk-formation is probably the most important factor in the normal rupture of the follicle, since closing the funnel or removing the duct apparently does not greatly delay ovulation.

There are cases of birds that have not been operated on, which have normally functioning ovaries, and oviducts apparently capable of functioning, which do not produce eggs because of some anatomical or physiological condition of the mouth of the oviduct which prevents the entrance of the yolk.

The fate of yolks or eggs set free in the body cavity depends apparently upon the physiological vigour of the bird. First, they may cause

* Comptes Rendus, clx. (1915) pp. 260-3 (1 fig.).
† Journ. Exper. Zool., xvii. (1914) pp. 395-424.

serious metabolic disturbances which cause death; second, they may be absorbed rapidly from the general peritoneal surface; or third, they may be walled off by peritoneum and then absorbed. The material from the absorbed yolks or eggs is apparently utilized in body metabolism, for autopsy showed that all the birds which were in good health were very fat.

The removal of the greater portion of an oviduct does not cause the atrophy of any remaining portion. The whole or any remaining part of an oviduct sewed at the funnel, or ligatured at any level, or with parts removed, passes through growth and cyclic changes, co-ordinated with changes in the ovary, exactly as a duct which has not been touched. The stimulation of the advancing egg is necessary for the discharge of the secretion of the duct, since a duct closed at any level functions only to the point where the passage is interrupted.

When any portion of the ventral ligament is removed it is not replaced, but all the remaining portions develop. The forward portion of the ventral ligament is necessary for the reception of the yolk by the funnel. The muscle-bundles which arise from the muscular cord in the ventral ligament along the uterus are probably an important part of the normal apparatus which expels the egg.

Some previous results may be recalled. The secretion of albumen occurs in the isthmus and uterus as well as in the generally recognized secretory region of the oviduct. There is some good evidence that the effective stimulus to secretion is mechanical. The amount of secretion by the duct depends in part on the intensity of stimulation, as is shown by double-yolked and triple-yoked eggs. The muscular activity of the walls of the oviduct are undoubtedly responsible for the shape of the egg. The excision of one-fourth of the albumen-secreting region and an end-to-end anastomosis of the remaining parts does not cause permanent loss of function in the oviduct. The bird began to lay again in four months, and the eggs were nearly normal. There seems to be a compensatory action on the part of the duct.

Development of Visual Cells in Amphibians.*—Guiseppe Levi has studied this in larvæ of *Salamandrina perspicillata*, *Bufo viridis*, and *Triton tæniatus*. The external division of the cell, with the characteristic appearance of a pile of disks, is not of chrondriosomic origin, but probably represents a cuticular formation. The truncated ellipsoid body in the internal division of the cell is derived from a concentration of a mass of chondriokonts; when it has acquired its definitive form it still retains its original chrondriosomic constitution.

Development of the Nerves of the Eye-muscles.†—D. Pedaschenko has studied this in various Lacertilian types and in dogfish. The earliest primordia are simple groups of elongated cells or nuclei, like the adjacent mesenchyme elements. There is every stage between a chain of cells and irregular clumps of protoplasm with crowded nuclei. Except a portion of the trochlear the primordia of these nerves to the

* Anat. Anzeig., xlvii. (1914) pp. 192–9 (2 figs.).
† Anat. Anzeig., xlvii. (1914) pp. 145–80 (9 figs.).

eye-muscles appear as isolated elements (neurocytes) in the mesenchyme, unconnected with the central nervous system or with the periphery. They must be widely distributed in the mesenchyme, and are rather diffuse to begin with. There are several paths in the embryo, and one of these becomes the main path. There is degeneration of some and exaggeration of one. From this general position the author goes on to give a detailed account of the development of the oculomotor, the trochlear, and the abducens.

b. Histology.

Mitochondria and Other Plasmic Structures.*—Jan Hirschler discusses the widespread occurrence of Golgi's apparatus, which has been described as an organellum of the cells of Vertebrates, Worms, Molluscs, and Arthropods. He has found in Ascidians, Spongilla, and Gregarines structures which correspond to Golgi's apparatus in their chemico-physical nature, in their structure, and in their topographical relations. He deals especially with the cells lining the stomach of *Ciona*, with the flagellate cells of *Spongilla* and with *Monocystis ascidiæ*, and describes in detail what these show in the way of mitochondria and Golgi's apparatus.

Minute Structure of Nerve-cells.†—Andreas von Szüts has made a study of the nerve-cells of the earthworm, with particular reference to the theory of Koltzoff and Goldschmidt that the neurofibrils form a firm internal framework, a sort of skeleton for the cell. The shape of the nerve-cell is very intimately connected with the structure of the neurofibrillar apparatus. In "nerve-cells" with an extremely elongated body, which occur in the earthworm in the annular nerves and at the exit of lateral nerves, there is no neurofibrillar meshwork, but the neurofibrils run parallel along the cell. The roundish and pear-shaped ganglion cells, on the other hand, are penetrated by a neurofibrillar meshwork. Certain cells, in which the neurofibrillar meshwork or framework is divided into two zones, show a perfect correspondence between the shape of the framework and the shape of the cell. In elongated pear-shaped cells the meshes of the internal framework are drawn out lengthwise, in spherical cells they are broader. It is concluded that the intracellular neurofibrils form a supporting framework.

Cortical Cell Lamination in Cerebral Hemispheres of Rodents.‡ A. E. B. Droogleever Fortuyn has studied the cortex of the cerebral hemispheres in rabbit, mouse, rat, guinea-pig, squirrel, hare, and waltzing mouse. The cell lamination and the situation of the areas generally agreed in different rodents, although important differences occurred. Some areas are characteristic of genera, others even of species. In some rodents some areas show a not uniform structure, an irregular mixing of two types of cell lamination.

* Anat. Anzeig., xlvii. (1914) pp. 289–311 (1 pl. and 3 figs.).
† Anat. Anzeig., xlvii. (1914) pp. 199–201.
‡ Archives Neurol. Psychiatry, vi. (1914) pp. 221–354 (2 pls.).

Bone in Sunfish.*—Kaschkaroff describes the development and structure of the bone in *Orthagoriscus mola*. The bone in the strict sense is a product of osteoblasts. In cell-less bone the osteoblasts sacrifice themselves in producing the matrix. Newly-formed bone, thus produced by the osteoblasts, is quite homogeneous and may probably remain structureless.

Connective tissue fibres may interpenetrate the bone and form the greater part of it. But this is no necessary condition of bone-development, although in most Teleosts the bone is mainly due to the connective tissue.

Between bone without cells and bone rich in cells there is no essential difference. Which kind is the more primitive phylogenetically cannot be decided at present.

The development of the cell-less bone of *Orthagoriscus* presents some resemblance to the development of cartilage. The various types of connective tissue may be terms in a series.

Elastic Cartilage in Intrapulmonary Bronchi of Mammals.†—G. Cutore calls attention to the frequent presence of elastic cartilage in the intrapulmonary bronchi in man, both in fœtus and adult. The elastic fibres in the fœtus mostly arise from special cells (elastoblasts); in post-natal life numerous fibres are derived from granules of elastin which are separated off from cartilage-cells. Cutore has tried other mammals—hedgehog, cat, dog, sheep, ox, pig, rat, guinea-pig, and rabbit. In the walls of the intrapulmonary bronchi he has found hyaline cartilage, but no true elastic cartilage. In ox, pig, and rabbit, he found some plates of cartilage which were invaded by a few strong elastic fibres which come from the surrounding connective tissue. But this is not true elastic connective tissue.

Cartilaginous Inclusion in Human Palatine Tonsils.‡—G. Alagna calls attention to the presence of a nodule of hyaline cartilage in the tonsils. There is nothing pathological about it, but probably a ("normoplastic") differentiation of connective tissue into cartilage, which may occur either in fœtal or post-natal life.

Chromaffine Bodies along the Human Œsophagus.§—G. Trinci discusses Thulin's description of paraganglia or chromaffine bodies along the œsophagus in man, and calls attention to his own work on similar structures in reptiles. He found in reptiles besides carotid paraganglia and a cardiac paraganglion, a series of chromaffine bodies intercalated between these in the supra-cardiac and cervical region. He described them as a cardiac-cervical chromaffine system, and it is to this that Thulin's bodies belong.

* Anat. Anzeig., xlvii. (1914) pp. 113–38 (14 figs.).
† Anat. Anzeig., xlvii. (1914) pp. 359–64 (2 figs.).
‡ Anat. Anzeig., xlvii. (1914) pp. 331–6 (1 fig.).
§ Anat. Anzeig., xlvii. (1914) pp. 352–6.

Appearance of Fat in Human Thymus.*—Th. Herrmann discusses the time of appearance of the fat in the thymus. It is well known that fatty tissue increases during the normal involution until the thymus fatty body is formed which has only slight, structureless, functionless remnants of the gland. The fatty tissue is developed in the child between the lobes of the thymus. In ninety-two cases examined, either fœtal or newly born, fatty tissue was found only in seven. It appears in the peripheral portions of the connective-tissue septa between the thymus lobes. In some cases fatty tissue was found in embryos 42 cm. in length, but in the great majority the fatty tissue develops after birth.

c. General.

Nutrition of Marine Animals.—B. Moore, E. S. Edie, and E. Whitley † have investigated the nutrition and metabolism of marine animals with especial reference to what nutritive material can be obtained from dissolved organic matter in the water. They have especially investigated the rate of oxidation and the output of carbon-dioxide in relation to the available food supply in the sea-water. Their experiments definitely settle that sea-water does not contain any appreciable amount of organic matter capable of acting as a nutrient medium for aquatic animals. The preponderating amount of food consumed by larger marine animals is utilized for increases of the animal by growth and for sexual reproduction, and but a small fraction is oxidized for the metabolic needs of the animal in other activities than growth and reproduction.

B. Moore and G. A. Herdman‡ have, in the same connexion, studied the effects in the lobster of prolonged abstention from food in captivity. Lobsters provided daily with a sufficient supply of fresh sea-water can be preserved alive without food during a period of over seven months. The live body-weight of such lobsters does not diminish during such a prolonged period of inanition. But while the actual weight of inorganic matter remains constant, the total dry weight and total organic weight are markedly diminished, and as a result the percentage of inorganic matter in the dry weight becomes increased. The total oxidizable organic matter may fall to considerably less than one-half of the initial amount. At the commencement of the period, protein, fat, and carbohydrate are oxidized almost equally, later the carbohydrate becomes exhausted, and although fat is still present, nearly all the oxidation falls upon the protein. There is a satisfactory correspondence between the amount of oxygen consumed by the animals throughout the period and the amount of organic matter disappearing. The oxygen consumed corresponds very closely to that required for oxidation of the organic matter disappearing, so that there is no reason to suppose that the animal utilizes any dissolved organic matter which might hypothetically be present in the sea-water.

The rate of oxidation is throughout a slow one, representable by

* Anat. Anzeig., xlvii. (1914) pp. 357-9.
† Rep. Lancashire Sea-Fisheries Laboratory, xxii. (1914) pp. 297-320.
‡ Rep. Lancashire Sea-Fisheries Laboratory, xxii. (1914) pp. 321-9.

120 to 130 milligrams per lobster of 220 to 300 grams at the commencement, and dropping to about half this quantity towards the end of the experiment. This amount corresponds to a little over one-tenth of a gram of protein or carbohydrate daily.

Animal Ecology.*—Charles C. Adams has prepared a useful guide to the study of animal ecology, which should have been noticed at an early date in our record. The ecologist is chiefly concerned with the responses of organisms—as individuals, groups, or associations—to their environment, both organic and inorganic. The author indicates the aims and methods of ecological study and gives abundant references to literature. A great part of the book is occupied with this copious bibliography, arranged in the main under three heads—the external conditions and their changes; the changes in organisms; and the adjustments between them.

Animal Communities in Temperate America.†—Victor E. Shelford has sought to build up a biological background for field zoology. The three leading ideas are: (*a*) the physiology of organisms as contrasted with the physiology of organs; (*b*) the phenomena of animal behaviour, especially in natural environment; and (*c*) the organized data of plant ecology. The result is a very interesting and valuable introduction to the study of animal associations and inter-relations. After discussing man's relations to nature, the animal's relations to its environment, the factors in the environment, and other general questions, the author deals with the communities of the large lake, of streams, of small lakes, of ponds, of "the tension lines" between land and water, of swamp and flood-plain forests, of dry and mesophytic forests, of thickets and forest margins, and of prairies. The relations between different communities are also treated of, and the relations of ecology to other branches of science. The work is scholarly, and should be known to all interested in the extension and deepening of field natural history.

Hypophysis in Chimæra monstrosa.‡—Mario Aresu describes the structure of the hypophysis in this fish. It is a flattened sac, with a chromophobic lobe attached to its dorsal surface posteriorly, and a chromophilous lobe attached to its ventral surface anteriorly. Its structure corresponds to the perimeningeal portion of the Selachian hypophysis. There is not any trace of a part corresponding to the large endocranial portion of the Selachian hypophysis.

In the dorsal lobe, with little affinity for stains, there are numerous sinusoids which collect the secretion and numerous nerve strands. The chromophilous lobe has a different structure. It has no connexion with the nervous tissue of the base of the diencephalon. Its secretion may pass in part into the sac of the hypophysis, but is mainly transported by the sinusoids.

* Guide to the Study of Animal Ecology. New York: Macmillan Company (1913) x and 183 pp. (7 figs.).

† Animal Communities in Temperate America, as illustrated in the Chicago Region: A Study in Animal Ecology. Chicago: (1913) xiii and 362 pp. (306 figs.).

‡ Anat. Anzeig., xlvii. (1914) pp. 181–92 (4 figs.).

It may be said that the hypophysis of Holocephali corresponds in the main to the perimeningeal portion of the hypophysis of Selachii. The hypophysial sac appears to arise as an outgrowth from the buccal ectoderm.

Posterior Upper Incisors of Rabbit.*—Chiavaro has made a study of the small incisors which lie behind the front upper incisors in the rabbit and other Duplicidentata. The result of his inquiry is the conclusion that these teeth function in mastication (the lower incisors biting against them), and that they also serve to protect the peridental mucosa of the palate. Chiavaro thinks that they are analogous in function to the cingulum and to the fifth cusp in human dentition.

Venous System of Dogfish.†—Chas. H. O'Donoghue has given an exceedingly careful description of the venous system of *Scyllium canicula*, of which a complete account was needed. He deals with the development in later embryos of 37 and 56 mm., and with the adult condition. The characteristic dilatation of the venous system to form sinuses renders the task a very difficult one.

Radiogenesis in Evolution.‡—Heber A. Longman argues that variations have arisen "not definitely and simply, but polychotomously." The key to the process has been "radiogenesis," and not orthogenesis. He refers to such "radial variation" as is to be seen in the Drepanidæ of the Hawaiian Islands, in the land snails of Oahu, and in the marsupials of Australia.

Tunicata.

Self-sterility in Ciona.§—E. M. East discusses the self-sterility (the practical impossibility of self-fertilization) discovered by Castle (1896) in *Ciona intestinalis*, and well known in some plants. Under uniform suitable conditions, individuals of *Ciona* vary in degree of self-sterility, it being exceptional to find an animal that is perfectly self-sterile. Self-fertility has never equalled cross-fertility, though the possibility remains that some animals may be self-fertilized as easily as they may be crossed with certain particular individuals. The ease with which the ova of any animal "A" may be fertilized by the sperm of other individuals may vary. A chemical basis for self-sterility is shown in Fuchs's experiments, by (*a*) the decrease in ease of cross-fertilization after contact of ova with sperm from the same animal, and by (*b*) the difference in ease of cross-fertilization after various artificial changes in the chemical equilibrium of the medium surrounding the ova.

From his studies on fertilization in flowering plants, East concludes that the secretions in the style offer a stimulus to pollen-tubes from

* Atti (Rend.) R. Accad. Lincei Roma, xxiii. (1914) pp. 296-302 (7 figs.).
† Proc. Zool. Soc. London, 1914, pp. 435-55 (2 pls. and 4 figs.).
‡ Proc. R. Soc. Queensland, xxvi. (1914) pp. 23-39.
§ Amer. Nat., xlix. (1915) pp. 77-87.

other plants, rather than an impediment to the development of tubes from the same plant. Specific stimulants are supposed to reside in the pollen-grains which can call forth the sugar secretion unless the pollen be that of the plant itself. Different hereditary complexes stimulate pollen-tube growth and in all likelihood promote fertilization; like hereditary complexes are without such effect. It may be that in animals the external portions of the membranes of the ovum are functionally zygotic in character.

INVERTEBRATA.

Mollusca.

α. Cephalopoda.

Japanese Cuttlefish.*—C. Ishikawa describes *Enoploteuthis chunii* sp. n., and compares it in detail with the other known species, *E. leptura*, from the coast of West Africa. The differences refer very largely to the proportions of parts. There are six rows of luminous organs on the ventral surface of the head in *E. leptura*, and five in the new species. The radula is very simple, and very like that of *Thaumatolampus*. Each row has seven denticles, with the formula 3221223. Five females were found, all with spermatophores attached dorsally under the mantle. The male is unknown.

C. Ishikawa and Y. Wakiya † describe *Moroteuthis lönnbergi* sp. n., which has thirteen pairs of hooks on the prehensile part of the tentacle and seven or eight suckers on the fixing apparatus. Very remarkable is the warty or plaster-like appearance of the mantle previously noticed by Lönnberg in another species. It is due to interesting lines of elevations and depressions of the dermis. The same authors also describe ‡ parts of a gigantic squid, probably *Moroteuthis robusta*, from the stomach of a sperm whale. The mantle was probably about four feet long. The dermis of the mantle shows the "plastered structure."

γ. Gastropoda.

Cells with Double Nuclei in Spermatogenesis of Paludina vivipara.§—Cesare Artom finds that some of the growing spermatocytes show two nuclei. Each of these is perfectly normal, and the two remain independent during the growth of the spermatocytes, and during the maturation and reduction processes. Artom supposes that the presence of two nuclei implies that the division of the cytoplasm of a spermatogonium has been suppressed. It may be that these binucleate elements give rise to the giant spermatozoa which occasionally occur.

* Journ. Coll. Agric. Univ. Tokyo, iv. (1914) pp. 401–13 (2 pls.).
† Journ. Coll. Agric. Univ. Tokyo, iv. (1914) pp. 445–60 (2 pls.).
‡ Journ. Coll. Agric. Univ. Tokyo, iv. (1914) pp. 435–43 (2 pls.).
§ Atti (Rend.) R. Accad. Lincei Roma, xxiii. (1914) pp. 45–7.

Regeneration in Littoral Gastropods.* — Paul Pelseneer finds that the tentacles of such Prosobranchs as *Purpura* and *Nassa* are regenerated more rapidly and regularly than those of terrestrial Pulmonates. The regeneration of the eye takes place most rapidly in young forms. The rate is hardly, if at all, lessened in darkness. The tentacles are very slow to regain their original length, or the eyes their diameter.

Pelseneer also studied the regeneration of parts in the littoral Turbellarian, *Leptoplana*, which is often found with traces of wounds. The rate of the regeneration varies directly with the degree to which the central nervous system is left intact. Where the part cut off is small, there is often a rapid healing up along the cut margin, instead of a regular regeneration, which is a slower process.

δ. Lamellibranchiata.

Alimentary System and Heart of Arca.† — Martin Matthias has made a detailed study of the alimentary system and heart in various species of *Arca*. The mouth lies behind the anterior adductor; the œsophagus is short and has a small, ventral diverticulum in *A. angulata*. The stomach is relatively small, and does not keep pace with the growth of the animal; it consists of a dorsal portion, the stomach proper, and a ventral portion, the stomach-intestine. In the stomach proper three parts can be distinguished—the cardiac portion, the fundus, and the pyloric portion, differing in relative sizes in different species. Both at the anterior and posterior end of the stomach there is a small cæcum. The openings of the hepatopancreas differ in number (ten or more) and in position.

The epithelium of the stomach differs in different species. Most striking is a band of high prismatic ciliated epithelium in the fundus of *A. barbata*, into which phagocytes may penetrate, probably for the absorption of food. Over the whole intestinal epithelium there are unicellular glands, which are probably digestive, and perhaps compensate for the absence of salivary glands.

All Arcacea have a "stomach-intestine" consisting of an intestinal groove and a sheath around the crystalline style. The two regions are partially separated by a prominent epithelial ridge with many unicellular glands, some of which secrete the cystalline style. The chyme from the stomach glides along the groove to the intestine proper. The epithelium of the sheath of the crystalline style consists of high prismatic cells with somewhat setose surfaces, which work the style into the stomach.

In some Lamellibranchs the crystalline style is secreted in an intestinal groove; in others there is a special separate cæcum for the style; in a third set there is a "stomach-intestine" succeeding the stomach and divided into an intestinal groove and a style-sheath.

The relation of the rectum to the heart differs in different species. In *A. platei* and *A. lactea* the pericardium and ventricle are perforated by the rectum. In *A. barbata* there is a complete separation of the

* C.R. IXe Congrès Internat. Zool. Monaco, 1914, pp. 172-3.
† Jen. Zeitschr. Naturw., lii. (1914) pp. 363-444 (4 pls. and 5 figs.).

heart into two halves, which are in contact with the rectum. In *A. noæ* and *A. angulata* the heart is double and distant from the intestine. In all Arcidæ there is an abdominal sensory organ on each side of the anus, which is sensitive to movements and impurities in the water.

In *Arca* there are always two separate pericardial cavities. There may be one ventricle with lateral lobes, or two ventricles. There may be a sphincter on each side between the ventricle and the auricle, or there may be auriculo-ventricular valves. The auricles consist of a larger lateral and a smaller median portion. The median portions communicate in *A. platei* and *A. scapha*. There is an aorta both anteriorly and posteriorly. A series of different grades occurs from single pericardium and ventricle to double pericardium and ventricle. In *A. scapha* the heart is remarkable in being supra-rectal. The author calls attention to the fact that *Arca* (*Barbatia*) *barbata* and *Arca* (*Barbatia*) *platei* are very closely alike as regards shells, and yet show very marked anatomical differences.

Estimating Age of Oysters.*—Anne L. Massy finds that reliance cannot be placed on the method of estimating the age of oysters by the groups of rings on the deep valve. She has dealt with 638 oysters of known age (from Ardfry Station in Galway Bay), and finds that an oyster of eighteen months or two summers has at least two rings, but may have as many as five. One of three summers has at least two rings, and may have six. A four-year-old oyster may have only three rings, or may possess seven or eight.

Arthropoda.

α. Insecta.

Evolution of Colour Pattern in Lithocolletis.†—Annette Frances Brown has studied the development of the colour in the pupal wings in this genus of Tineid moths. The primitive colour pattern is a series of seven uniformly coloured pale yellow transverse bands, separated from one another by unpigmented areas. The disposal of these bands is dependent upon the course of the longitudinal nervures, since the points of origin or the tips of the veins mark the positions of the unpigmented fasciæ between the bands.

From this primitive colour pattern the various types of the genus have been derived. Evolution has taken place in definite directions under the action of three general processes, which were found to be sufficient to explain the origin of the different colour patterns. 1. The middle portion of a band may be produced distally until it comes in contact with the band beyond it. 2. The extremities of a band may be broadened by being produced proximally. 3. The extremities of a band may be narrowed by the retraction of pigment from their outer edges.

During pupal development these phylogenetic changes are repeated

* Sci. Invest. Fisheries Ireland, 1913, No. 2 (published 1914) pp. 1–12 (11 pls.).
† Journ. Acad. Nat. Sci. Philadelphia, xvi. (1914) pp. 105–65 (2 pls. and 24 figs.).

only to a very limited extent; recapitulation is confined to those portions of the wing in which there has been the least modification of the primitive transversely banded type of marking.

These bands, either in their primitive or modified shape, constitute the ground colour. On this a second darker series of elements, the markings proper, also usually transverse, are superimposed. The different levels at which evolution in the pattern of the ground colour has halted—that is, the configuration of the areas of ground colour—are the important factors in determining the phylogenetic sequence of large groups. The particular colours and markings determine the positions of the species within these groups.

These markings appear at the limits between ground colour and unpigmented areas, as one or more lines of dark scales along the edge of a band adjacent to a white fascia or streak. The relative time of appearance of the dark margin of any band in ontogeny is dependent upon the time when the edge of that band became fixed in phylogeny. If late racially, it will be late individually. This holds good irrespective of whether or not there is recapitulation of phylogenetic changes in the configuration of the colour areas during pupal development. Therefore, in the second and more recent set of characters there is an actual recapitulation. A dark marking once permanently established in the race tends to reappear independently of the ground colour, so that later suffusion of the unpigmented area contiguous to it with ground colour, or the shrinking away of the ground colour, does not affect its permanency.

Later on in phylogenetic history additional dark markings, other than those contiguous to unpigmented areas, may appear. The development of these characters in the pupa becomes much abridged, and, concomitant with this, their time of appearance is pushed back into the earlier stages of pupal development, so that they may appear simultaneously with or even earlier than characters which are much older phylogenetically. However, only those characters permanently established and of long standing in a species exhibit this precocity of development; recently acquired or variable characters appear in the order of their phylogenetic sequence. When certain characters appear unduly early in pupal development, physiological factors probably act directly in bringing about this result.

The most far-reaching and widespread changes have taken place toward the place of the base of the wing, proximal to the transverse vein. The final result is production of a uniform ground colour which will be attained earliest near the base of the wing where evolution has proceeded most rapidly.

This observed evolution in the pattern of the ground colour suggests that the uniform yellowish ground colour which suffuses the wing in the higher Lepidoptera, beginning at the base and spreading distalward, is the outcome of a phylogenetically older type of marking, originally banded, and later fused to uniform colour, and the markings are a second series superimposed upon the first.

The observations made clearly point to the conclusion that the evolution of the colour pattern in *Lithocolletis* has been orthogenetic.

Life-history of Warble-Flies.*—G. H. Carpenter, T. R. Hewitt, and T. K. Reddin report some new facts in the life-history of warble-flies. Like Gläser and Hadwen, they have previously demonstrated that the eggs are hatched while fixed to the hairs of the skin. They also described, as Gläser did, the structure of the minute spiny first-stage larva previously unknown outside the egg. Of the various results which they now set forth the most important is the fact, indicated both by the muzzling experiments and by direct observation, that this first-stage maggot bores into the host-animal directly through the skin, as was generally believed to be the case until the discovery of the second-stage larvæ in the gullet led to the view that the mode of entrance is by way of the mouth.

The fly almost exclusively lays its eggs on the legs, not confining itself to any particular area, but *Hypoderma bovis* at least shows a decided preference for the heel or hock-joint of the hind legs. In the case of *H. lineatum*, the earlier of the two flies, the eggs are laid in rows; in the case of *H. bovis*, the eggs are laid singly and quickly.

On the third day the minute maggots are ready to hatch, and hatching occurs on the fourth day. The first-stage larvæ (0·8 mm. in length) is distinguished by the relatively immense strength of its mouth-hooks and by its spiny armature. Those described from the gullet are really second-stage larvæ.

Muzzling experiments proved that the first-stage larvæ bore through the skin of the back. The process was observed; it lasted for six hours. Minute holes are seen, and next day these are represented by small eruptions visible to the naked eye. The course of the larvæ beneath the skin has not yet been traced. It seems probable that the sub-mucous coat of the gullet is a common resting-place for the parasites on their way to their final position beneath the skin of the back.

The destruction of warble-maggots † is discussed by J. L. Duncan, T. R. Hewitt, and D. S. Jardine. Many substances were found to be useless, many killed only a small percentage. A mixture of archangel tar and paraffin is deadly, but it is harmful to the cattle. Sulphur-dioxide applied under pressure individually to each maggot for less than a minute kills 93 p.c. of the maggots and causes no harm to the cattle.

Brain of Cockroach and Mealworm.‡—F. Bretschneider has made a thorough study of the brain of *Periplaneta orientalis* and *Tenebrio molitor*. The brain of the cockroach is very typical with proto-, deutero- and trito-cerebrum. The protocerebrum consists of optic ganglion, ocellar ganglion, lobus protocerebralis, pons protocerebralis, median protocerebrum. The mushroom-shaped bodies or corpora pedunculata lie in front on each side of the median protocerebrum. They show with great clearness "cup-glomeruli" or calices, which have not been much noticed by previous investigators. Their importance lies in their fibrous connexion with all the important parts of the brain. There is a sexual dimorphism in the compound eyes and in the ocelli, and likewise to some extent in the

* Journ. Dept. Agric. Ireland, xv. (1914) pp. 105–21.
† Journ. Dept. Agric. Ireland, xv. (1914) pp. 121–32.
‡ Jen. Zeitschr. Naturw., lii (1914) pp. 269–362 (3 pls. and 19 figs.).

optic ganglion. Otherwise there is no difference as regards the brain between the two sexes.

The ocelli and the compound eyes are both connected with the pons protocerebralis, which may be regarded as an optic centre. The "central body" of the protocerebrum receives the dendrites of commissural fibres from all parts of the brain, and is in direct connexion with the motor centres of the ventral chain of ganglia. A comparison of the brains of different insects shows that the degree of development exhibited by the central body is in inverse ratio to that of the mushroom-shaped bodies. Bretschneider concludes that the central body is a primary reflex- or association-centre, and the mushroom-shaped bodies a secondary association-centre. The latter are the chief seats of the more complex instincts and of memory. That the cockroach has memory is proved experimentally. The innervation of the antennæ is peculiar, the first joint having special motor and sensory nerves which have a complex course. The tritocerebrum and the deutorocerebrum consist of cells and glomeruli. Besides the previously described tritocerebral commissure there is a second which also contains motor fibres innervating the œsophageal musculature.

The brain of *Tenebrio* undergoes during the metamorphosis an important increase in size and a change of shape and position. The optic ganglion and the pons are almost entirely formed anew. There is a notable increase in the size of the central body, the protocerebral lobes, the deuterocerebrum, and the tritocerebrum. The mushroom-shaped bodies remain almost unchanged.

Bretschneider connects the post-embryonic development of the pons and the central body with the new formation of the optic lobe, the pons being regarded as an optic centre and the central body as a primary reflex centre. The cell proliferation proceeds from special formative centres. Two of these are very distinctly evident in the optic ganglion; one is to be clearly seen in the deuterocerebrum, and another in the tritocerebrum.

The mushroom-shaped bodies have no developed calices. They represent a state intermediate between that of *Lepisma* and that of *Periplaneta*. Characteristic of *Tenebrio* is the fine development of the "parosmetic mass" which lies in the deuterocerebrum between the trabeculæ of the mushroom-shaped body and the olfactory glomeruli. The deuterocerebrum of the larva has to do with movement and nutrition, but in the adult it has to do also with the finding of the other sex and of a place for egg-laying. In the meal-beetle the pharyngeal nerve arises from the protocerebrum. In the larva the labral nerve unites for a certain distance with the mandibular.

The mushroom-shaped bodies develop in insects from small beginnings (in forms like *Lepisma* and *Tomocerus*) and become functionally the most important part of the brain. As they increase the central body decreases. Bretschneider recognizes six grades: (1) in Apterygota, the central body is large and the mushroom-shaped bodies are primitive; (2) in Hemiptera, Diptera, Libellulidæ, the central body is large and the mushroom-shaped bodies are unimportant; (3) in Coleoptera and lower Hymenoptera, the central body is still large, but the mushroom-shaped

bodies are on the increase; (4) in Orthoptera and Lepidoptera, the central body is still large and the mushroom-shaped bodies have distinct calices; (5) in solitary Hymenoptera with artistic capacities, the central body is relatively smaller and the calices of the mushroom-shaped bodies are larger; (6) in social Hymenoptera, the central bodies are small. and the calices of the mushroom-shaped bodies reach their highest grade of development.

Migration of Larval Phylloxera.*—B. Grassi discusses at length the emigration of the newly born first larval stages of the Phylloxera of the vine, before they begin to eat. It is a normal phenomenon and occurs on a much more extensive scale than was supposed by Faucon, who first observed it.

Mouth-parts of Glow-worm Larva.†—Kathleen Haddon describes the mouth-parts and the manner of feeding in the larvæ of *Lampyris noctiluca*. Only the mandibles are strongly chitinized; the first and second maxillæ are fleshy. The mandible is penetrated by a canal which communicates with the mouth, as Meinert described. Through this a dark fluid is exuded. The arrangement of the mouth-parts is such that no solid matter can enter the gullet. This is prevented by the numerous outward-pointing hairs, which strain off particles. The pharynx forms a suction-pump, and the details of this are described. The larvæ feed on snails, apparently without any preliminary anæsthetizing. The jaws move continuously when the larva is feeding, and the mouth-parts are bathed with the juices of the snail, which are then sucked into the extremely narrow œsophagus. The method is therefore different from that exhibited by the larvæ of *Dytiscus*, which are able to close the mouth completely and take in the juice by the mandibular tubes only.

New Thysanoptera.‡—Richard S. Bagnall continues his studies on Thysanoptera. He describes *Cranothrips poultoni* g. et sp. n. collected by E. B. Poulton near Fremantle, Western Australia. It comes very near *Ankothrips*, but the apex of the first antennal segment is strongly produced inwardly, with the inner edge of the produced part serrate. Among the other forms described are *Eolothrips brevicornis* sp. n., shaken from a flower at Cape Town by E. B. Poulton; *Heliothrips brunneipennis* sp. n., from Ceylon; *Docessissophothrips laticeps* sp. n., found in Sarawak under bark along with termites.

Behaviour and Local Distribution of Thysanoptera.§—A. Franklin Shull has continued his study of Thrips insects. He divides them into two groups:—1. Interstitial species, living in closely concealed situations, as among the florets of Compositæ, or in clusters of young leaves. 2. Superficial species, living on exposed surfaces, either on grasses (poëphilous) or on the leaves of plants other than grasses (phyllophilous).

* Atti. (Rend.) R. Accad. Lincei Roma, xxiii. (1914) pp. 19–30.
† Proc. Zool. Soc., 1915, pp. 77–82 (1 pl.).
‡ Ann. Nat. Hist., xv. (1915) pp. 315–24 (2 figs.).
§ Amer. Nat., xlviii. (1914) pp. 161–76.

The interstitial species are further divided into anthophilous forms (flower-dwellers) and phlœophilous forms (under bark scales on trees).

Experiments on *Euthrips tritici* show that it is positively phototropic when disturbed, in both larval and adult stages. It is positively stereotropic, and the stereotropism is stronger than phototropism, at least under certain circumstances. Some individuals appear to be on the whole positively geotropic; others are indifferent.

Experiments with *Anaphothrips striatus* show that adult males are usually negatively phototropic. Females taken from exposed situations are usually indifferent to light, those from concealed situations are usually negative. The larvæ are usually indifferent to light, regardless of the kind of place from which they were taken. A single larva that was positive was made negative by keeping it in the dark. Adults are positively stereotropic. The females and larvæ are positively geotropic.

Experiments on *Anthothrips verbasci* show that adults taken from concealed situations are usually negatively phototropic: those from exposed places tend to be indifferent to light. The larvæ are all negatively phototropic, except the full-grown ones, which may be indifferent. The larvæ are plainly positively stereotropic, the adults less plainly so, or not at all. Neither adult nor larva responds to gravity.

Shull's conclusion is that the outdoor behaviour and distribution of the Thysanoptera are in large measure the result of responses to simple stimuli, and do not imply any degree of choice. The responses are often adaptive, but they are probably not purposeful. How they have arisen is unknown. Natural selection may be responsible for the preservation of the useful, and it may have eliminated responses that were harmful. But other responses of no value whatever, though quite harmless, may have been allowed to persist, without help or hindrance from selection.

Thrips as Pollinator of Beet-flowers.—H. B. Shaw * has found that beets, supposed to be self-fertilized, are in every generation cross-fertilized, and that an important agent in the process is a minute unconspicuous Thrips insect, so small that it readily passes "through the meshes of fine silk chiffon." Perhaps other Thrips insects may be a cause of unsuspected cross-pollination and unaccountable "mutation" in the breeding of cereals and other plants. W. E. Castle † calls attention to the great importance of this to students of genetics.

Mouth-parts of Anoplura.‡—Bruce F. Cummings describes the mouth-parts in *Polyplax* (*P. oxyrhynchus*), which include two chitinous structures lying together behind the pharynx, which are quite probably mandibles, and thus traces of the mandibulate ancestry of Anoplura. In another species, *P. brachyrhynchus*, there is an œsophageal sclerite just behind the mouth-opening. This sclerite (sometimes called lyriform organ, and homologized with the hypopharynx) is associated with "glands" (better called basal pieces). They are almost unique in the

* Bull. U.S. Dept. Agric., No. 104 (July 1914).
† Amer. Nat., xlix. (1915) pp. 121–2.
‡ Ann. Nat. Hist., xv. (1915) pp. 256–9 (2 figs.).

comparative anatomy of the insect-mouth, but occur in typical form in the sub-order Ischnocera of the Mallophaga. This corroborates Mjöberg's view that there is an intimate phylogenetic relationship between Anoplura and Mallophaga.

ε. Crustacea.

Persistent Parthenogenesis in Daphnia.*—A. M. Banta notes that a hundred generations of *Daphnia pulex* have been reared parthenogenetically without sexual forms appearing at any time. There was no evidence of decreased vigour or loss of vitality, and it appears that there is not a necessary sexual cycle in this Daphnid. The facts corroborate the conclusion that the sexual cycle in *Daphnia* is not an inherent, necessary thing, but that it is determined by external conditions.

Remarkable New Cirripede from the Chalk.†—T. H. Withers described from the Chalk of Surrey and Hertfordshire a remarkable new Cirripede, *Proverruca* sp. n., occupying a position somewhat intermediate between Pollicipedidæ and Verrucidæ, but included as a primitive Verrucid. A rostral-latus and a carinal-latus are present on the rostro-carinal side, and there are no interlocking ribs developed on any of the valves.

Parasitic Eucopepoda from Tanganyika.‡—W. A. Cunnington gives an account of three new species of *Lernæocera*—the only genus of Lernæids which is known to occur parasitically on fresh-water animals. It seems that the fishes of fresh-water are relatively seldom the prey of parasitic Eucopepoda. Large numbers of fishes were examined on the Third Tanganyika Expedition, and on only two were such parasites discovered. Representatives of the Argulidæ, on the other hand, were taken eighteen times. In ponds and crowded conditions the number of parasites may, of course, be greatly multiplied.

Annulata.

Studies on Polychæts.§—The late Lewis N. G. Ramsay discussed the relationships of the closely allied genera, *Ceratocephale* and *Tylorhynchus*, the former being, so far as known, confined to the Atlantic, the latter to the Pacific Ocean. In *Tylorhynchus* the parapodium lacks the neuro-ligule, the neuro-cirrus is normal, and the eyes are present; in *Ceratocephale* the neuropodium bears a well-developed ventral ligule as well as the setigerous lobe, the neurocirri are double, and eyes are absent. The conclusion is expressed that the two genera should be kept distinct.

* Year-book, Carnegie Inst. Washington, xiii. (1914) p. 131.
† Proc. Zool. Soc., 1914, pp. 945–53 (1 pl. and 1 fig.).
‡ Proc. Zool. Soc., 1914, pp. 819–29 (1 pl. and 1 fig.).
§ Proc. Zool. Soc., 1914, pp. 231–5.

In another paper* Ramsay described Nereids from the Pacific, with particular reference to a representative of the little known genus, *Micronereis*, which is apparently identical with *M. variegata* Claparède of European waters, the solitary species of the genus. He argues that *Micronereis* may be reasonably regarded as a more or less unaltered representative of a primitive ancestral form of the Nereidæ. The collection also included the remarkable and interesting *Nereis cyclurus* Harr., a study of which affords some new facts as to setæ.

Atlantic Chætopterids.† — F. A. Potts describes three new forms from the coastal waters of the Gulf of Georgia and Puget Sound—*Mesochætopterus taylori* g. et sp. n., *Phyllochætopterus prolifica* sp. n., and *Telepsarus* sp. The new genus includes Chætopterids with a well-developed peristomial collar and a pair of long peristomial tentacles. The body is divided into three regions. The anterior contains nine to thirteen setigerous segments; the parapodia are represented by short and conical notopodia with capillary setæ; in the fourth setigerous segment several of the dorsal setæ are enlarged. The median region is composed of two or three elongated segments, forming dorsally a flat region, with continuous lateral borders, covered with glandular epithelium and ornamented with transverse ridges. Typically the notopodia are rather enlarged, conical, and fleshy, with a groove running down the inner border; the neuropodia are single in the first, double in the succeeding segment or segments, and contain uncini. The posterior region contains a large number of segments similar to those in *Chætopterus*, but with much shorter notopodia. A dorsal ciliated groove runs from the mouth along the median line to the posterior end. In one or more of the median segments the lips are enlarged to form a fleshy organ.

The new genus partly bridges the gap between the remarkable form *Chætopterus* and the other members of the family. It agrees with *Chætopterus* in the reduced number and specialized character of the segments of the median region. It resembles *Phyllochætopterus* in the continuous ciliated groove and the long tentacles.

In *Phyllochætopterus pacifica* the tubes are slender and creeping, usually containing several individuals, and possessing several short branches opening to the exterior. There is asexual multiplication by autotomy. Fragmentation takes place in the median region, and regeneration proceeds on the anterior and posterior surfaces of the plane of rupture. The median segments usually regenerate anterior or posterior segments, and only segments like themselves when the other two regions have been completed.

The genus *Telepsarus* has been hitherto known only from the Mediterranean and the Red Sea. It is a very common and widely-distributed member of the beach fauna of British Columbia. The author describes *Phyllochætopterus anglica* sp. n. from the English Channel. The tubes are creeping, and often several run parallel with short lateral connexions. The same system of tubes includes more than one in-

* Proc. Zool. Soc., 1914, pp. 237–50 (7 figs.).

† Proc. Zool. Soc., 1914, pp. 955–94 (6 pls. and 13 figs.).

dividual. A comparison is made of the species of *Phyllochætopterus* which form true colonies, and some morphological questions are discussed.

Genus Prionospio.*—M. Caullery discusses several species of this genus and proposes a division into two sub-genera. The sub-genus *Prionospio* s. str. will include species, e.g. *P. steenstrupi*, in which the first setigerous segment has reduced parapodia without branchiæ. The sub-genus *Paraprionospio* nov. will include species, e.g. *P. pinnata*, in which the first pair of parapodia are like those that follow and bear branchiæ.

Nematohelminthes.

Nemathelmia and Kinorhyncha of Clare Island.†—R. Southern reports on 83 Nemathelmia and Kinorhyncha, all of which, except *Parachordodes violaceus*, are additions to the Irish fauna. He also records two Chætognaths—*Sagitta bipunctata* and *Spadella cephaloptera*. The list includes one new family, Ogmidæ, eight new genera, twenty-eight new species, and twenty-six others which have not previously been recorded from the British Isles. This larger number is the more remarkable because the collection was obtained as a by-product of the search for other groups. The genus *Nuada* is remarkable for the slenderness of the body and the thickness of the cuticle; *Halaphanolaimus* is most closely related to *Aphanolaimus*; *Cricolaimus* has a rounded head with a single row of four long sub-medium hairs, lateral sense-organs in the form of thick spirals, a median ventral pre-anal row of fourteen supplementary organs consisting of tubular chitinous ducts, into which open large unicellular glands; *Dayda* seems to be most closely related to *Diodontolaimus*, but differs strikingly in the structure of the buccal cavity, which is conical and armed with three teeth: *Diodontolaimus* is characterized chiefly by the structure of the cylindrical buccal cavity, which is armed at its anterior end with two subventral teeth: *Fiacra* is closely related to the group containing the genera *Thoracostoma*, *Enoplus*, and *Triodontolaimus*: *Demania* shows in the structure of the head and buccal cavity a distant affinity with the genus *Oncholaimus*.

The author describes new species of *Chætosoma* and *Desmoscolex*, interesting additions to the British fauna. The new family Ogmidæ is established for free-living Nematoda of small size. The body is composed of numerous segments, each bearing a number of recurved spines regularly arranged in rows. The head is composed of several narrow rings without spines. The œsophagus terminates in a rounded bulb, and is armed with a chitinous spear nearly as long as the œsophagus. The intestine is a simple tube, and the anus is ventral, the ring containing the anal aperture being modified. The type is *Ogma murrayi* g. et sp. n. Five Echinoderidæ are described, and it is noted that no representatives of this group have been previously recorded from the British Isles.

* Bull. Soc. Zool. France, xxxix. (1914) pp. 355–61 (2 figs.).
† Proc. Irish Acad., xxxi., Clare Island Survey, pt. 54, pp. 1–80 (12 pls.).

Indian Nematodes.*—F. H. Stewart describes new species of *Oxysoma*, *Heterakis*, *Dacnitis*, and *Atractis*, as well as some larval forms and *Oncholaimus indicus* von Linstow.

Platyhelminthes.

Intermediate Host of Schistosomum japonicum.†—K. Miyairi and M. Suzuki have found that the intermediate host of this remarkable Trematode is a small fresh-water snail—one of the Hydrobiidæ. The developing eggs were found in the dung of a bull-calf; the miracidium is hatched when water soaks in. When numerous miracidia are put into a vessel with the fresh-water snails infection is accomplished within two hours. The mode of infection is the same as in the case of the liver-fluke. Sporocysts occur in special places, such as the floor of the mouth-cavity, the vicinity of the cerebral and pedal ganglia, and the gills. As many as fifty rediæ may be seen in one sporocyst. The first free rediæ were seen on the twelfth day. The redia has an extraordinary power of elongation. Almost ripe cercariæ with bifid tails were seen after seven weeks. Their general structure is described. Some of them seem to spend the winter in their hosts, but no young rediæ were seen in the snail in the winter. When mice were placed in a large dish with infected fresh-water snails they became infected. The infection was more rapid when the snails were broken up. When some infected water was kept for half an hour on the skin of the mouse a very severe infection resulted.

New Trematode.‡—E. André describes *Mesocœlium carli* sp. n. from the small intestine of a tortoise (*Cinixys belliana*) from Uganda. It is oval in shape, 1·3 to 1·9 mm. in length, with a delicate cuticle. The two branches of the gut extend about halfway along the body. There are two spherical testes. The ovary is also spherical. The coils of the oviduct, which are not complicated, occupy most of the posterior half of the body. Between the branches of the gut and the periphery of the body lie the diffuse yolk-glands.

Structure of New Polystomum.§—F. H. Stewart gives a description of the structure of *Polystomum kachugæ* sp. n. from the urinary bladder of a water-tortoise (*Kachuga lineata* Gray), and compares it in detail with the six previously established species.

Trematode Parasites of Australian Birds.‖—William Nicoll reports on fifteen Trematodes from North Queensland birds, bringing his list up to twenty-three. He examined 114 birds belonging to fifty species, and found seventy-seven infected with parasitic worms—about 100 different forms altogether. Echinostome and Holostome Trematodes seem to be unusually frequent, but it cannot be said there is much that

* Records Indian Museum, x. (1914) pp. 165–93 (6 pls.).
† MT. Medicin. Fakultät Univ. Kyusha Fukuoka, i. (1914) pp. 187–97 (2 pls.).
‡ Rev. Suisse Zool., xxiii. (1915) pp. 91–3 (1 fig.).
§ Records Indian Museum, x. (1914) pp. 195–205 (4 pls. and 3 figs.).
‖ Parasitology, vii. (1914) pp. 105–26 (2 pls.).

is distinctive in the parasites of Australian birds. Many of these are migratory and their parasites are in consequence in many cases identical with, or very closely related to, those which occur in the same or similar birds in Europe and Asia. This is well illustrated by the common occurrence of such widely distributed parasites as *Echinostomum revolutum* and *Notocotylus attenuatus*. Among the new forms is *Platynotrema biliosum* g. et sp. n., a brilliantly-coloured representative of the Dicrocœliinæ from the gall-bladder of a stone-curlew.

New Genus of Tapeworms.*—F. E. Beddard describes *Monarcocestus erethizontis* g. et sp. n. from *Erethizon dorsatum*, the Canadian tree-porcupine. It belongs to the Acoleidæ. The scolex end of the living worm swayed about with considerable vivacity. The following characters define the new genus. Scolex unarmed; proglottids not longer than broad. Genital pores regularly alternating. Excretory tubes two pairs, lying side by side, connected by a transverse vessel from the inner tubes in each proglottid; no network. Longitudinal muscles feebly developed, without bundles. Reproductive organs visible in the first or second proglottid; first genital pore in the sixth proglottis. Testes numerous in transverse rows posteriorly, within the area bounded by the excretory vessel. Sperm-duct at first very wide and covered by glandular cells: after this short and narrow, without coil or seminal vesicle. Cirrus-sac large and very muscular; cirrus unarmed. Ovary curved in front of smaller vitelline gland. Vagina present in a few early proglottides, later aborted with the exception of a spherical receptaculum seminis. Uterus retiform, meshwork later tending to confluence. Eggs with delicate shell. The author compares *Monarcocestus* in detail with *Shipleya*, and shows how it differs from that genus.

Fimbriaria.†—O. Fuhrmann describes *Fimbriaria intermedia* sp. n. from the eider-duck, and discusses the peculiarities of *F. fasciolaris* Pallas. The fragile scolex is replaced by a pseudoscolex. The portion of the strobila following the pseudoscolex has lost its external strobilation, but shows some trace of internal segmentation (disappearing in contracted forms of *F. fasciolaris*). The absence of segmentation in the ovary and uterus has led to the disappearance of external segmentation. There is a series of unilateral genital pores and ducts, but the ovary is reticulate, and in *F. fasciolaris* the ovaries of different segments are fused. The uterus in both species is reticulate and forms one organ throughout the ripe proglottides. The number of uterine canals corresponds to the number of male copulatory organs. Fuhrmann considers the resemblances between *Fimbriaria* and *Hymenolepis*, such as the three testes, the two seminal vesicles (one within and one outside the cirrus pouch), the crown of ten hooks on the scolex, and comes to the conclusion that, in spite of the great peculiarity of the uterus, the genus *Fimbriaria* should be ranked in the family Hymenolepidæ. The reticulate structure of the ovary, so striking in *Fimbriaria*, is seen exceptionaally in *Hymenolepis* (*H. bisaccata* Fuhrmann).

* Proc. Zool. Soc., 1914, pp. 1039–55 (9 figs.).
† C.R. IX^e Congrès Internat. Zool. Monaco, 1914, pp. 437–57 (19 figs.).

New Avian Cestode.*—H. A. Baylis gives an account of the structure of *Tetrabothrius strangulatus* sp. n. from an albatross (*Diomedea irrorata*). It is very small—a complete specimen probably being about 60 mm. long, with about 250 proglottides. The maximum width observed was about 0·77 mm. A marked feature is the "strangled" appearance due to a very marked demarcation of the head from the neck. The small number of testes (eight to nine) is also characteristic. In its internal organs it approaches closely to *Tetrabothrius heteroclitus* Diesing.

Incertæ Sedis.

Enigmatical Animal.†—M. Caullery returns to the peculiar animal which he has made the type of a new family, Siboglidæ, of unknown affinities. The creature lives in an annulated tube, and is somewhat suggestive of the more delicate Chætopterids, like *Phyllochætopterus*, but the bad state of preservation made definite statements difficult.

Echinoderma.

Abnormal Gills of Porania pulvillus.‡—James F. Gemmill describes a specimen with infra-marginal actinal as well as abactinal gills. Starfishes with well-developed marginal plates (Phanerozonia) have their papulæ or gills limited to that part of the abactinal surface which is bounded by the supero-marginal plates. The case described shows that this does not always hold. Moreover, Gemmill has recently shown that the larval history of the phanerozonate *Porania* resembles in its essentials that of the typically cryptonate *Asterias*, both species having a feeding bipinnarial larva which changes into a brachiolaria and becomes attached at metamorphosis. "Probably the occasional presence of infra-marginal gills in *Porania* is not due directly to atavistic or ancestral causes, but is a parallel manifestation, in an individual belonging to a particular asterid Family, of a tendency or potency which has been fully realized in the various members of numerous other Families."

Development of Some Japanese Echinoderms.§—Th. Mortensen finds that the larvæ within an order or family have certain characters in common. The larva of *Strongylocentrotus pulcherrimus* has for body-skeleton long club-shaped rods and an elongated posterior end of the body, as is the case in the larvæ of *S. droebachiensis* and in true *Echinus* species. This leads Mortensen to think that *Strongylocentrotus* is nearly related to the Echinidæ *sensu stricto* and not to the Toxopneustidæ. In the latter the larvæ have quite another shape, namely a

* Proc. Zool. Soc., 1914, pp. 407–13 (4 figs.).
† Bull. Soc. Zool. France, xxxix. (1915) pp. 350–3 (8 figs.).
‡ Proc. Zool. Soc., 1915, pp. 21–3 (1 fig.).
§ Annot. Zool. Japon, viii. (1914) pp. 543–52 (2 figs.).

short body with a complicated body-skeleton forming a peculiar frame. In the later stages of *S. pulcherrimus* the long body-rods are absorbed and the body shortened.

The larva of *Toxocidaris tuberculatus* is quite different in shape and skeleton from *S. pulcherrimus*. In the first stage it is like *Toxopneustes pilosus*; the body is short and the skeleton of the body forms a frame, the rods being very thorny. In a later stage a posterior cross rod is developed, ending in two very peculiar postero-lateral antler-like rods. Mortensen's reference of *Toxocidaris* to the Echinometridæ has not yet received any confirmation from his study of the larvæ.

The larvæ of three Temnopleuridæ agreed in body-skeleton. So did four Clypeastroids. The case of one of these, *Laganum fudsiyama* (or perhaps *pellucidum*), is particularly interesting, for it is the first Echinoderm from the deeper waters (200 to 800 metres) whose development has been studied. It has quite typically pelagic larvæ of the common Clypeastroid shape. While believing that deep-sea Echinoderms in general have no pelagic larvæ, but undergo more or less direct development, Mortensen thinks that there are some—perhaps only among archibenthal forms, and not among those from very deep waters—that have pelagic larvæ. He suggests that in the case of a small species *Orechinus* from the Sagami Sea and in *Salenia pacifica* there will be pelagic larvæ as in the species of *Laganum* already noted. In *L. decagonale* the eggs are large, 0·5 mm. in diameter, and with yolk; the development is shortened—the whole metamorphosis being accomplished in three or four days. The larvæ are pelagic, reduced, and very variable in shape. They may show four, three, or two processes, or only one, or none; but the metamorphosis goes on just the same whatever be the number. There is a general ciliation of the whole body; the intestine is rudimentary and without an anus; the mouth is very small and the larva does not seem to feed.

In *Asterina pectinifera* the eggs are small and the larvæ pelagic, a contrast to *A. gibbosa*, which has large eggs and pelagic larvæ. The larva of *A. pectinifera* has a Brachiolaria stage. In *Asterias calamaria* there is autotomy in the younger stages. Nearly all the larger specimens opened contained genital organs with large, white, biserially arranged oval eggs, but these turned out to be the eggs of a parasite, probably a Cirripede.

Tetramerous Sea-Urchin.*—A. Robert calls attention to a specimen of *Sphærechinus granularis*, which showed a thorough-going tetramerous symmetry. No details are given.

Indian Ocean Spatangidæ.†—René Koehler gives an account of the Spatangidæ in the collection of the Indian Museum, including new species of *Pourtalesia*, *Aceste*, *Lorenia*, *Prymnaster*, etc. Out of the thirty-one species described, thirty-one are new, and we refer to the memoir especially because of its detailed description and fine illustration of the minute pedicellariæ.

* Bull. Soc. Zool. France, xxxix. (1915) p. 353.

† Echinoderma of Indian Museum, pt. viii. (1914) pp. 1–258 (20 pls.).

Cœlentera.

Australian Alcyonarians.*—E. A. Briggs reports on a collection of Alcyonarians from the eastern and southern coasts of Australia, from depths of 15 to 300 fathoms. The collection includes twenty-seven species, of which three are new—*Mopsea plumacea*, *M. repens*, and *Plumarella australis*. These are carefully described, with details as to the polyps and spicules. To the descriptions of the other species, previously given by Thomson and Mackinnon and others, some additions are made.

Pennatulaceæ of the Cape of Good Hope and Natal.†—J. Stuart Thomson reports on a collection which includes *Pteroeides isosceles* sp. n. and *Umbellula aciculifera* sp. n. A careful study has been made of *Actinoptilum molle*, probably the commonest Pennatulid in South African seas.

Madrepore Corals from Great Depths.‡—Ch. Gravier directs attention to the number of Madrepore corals dredged by the 'Prince of Monaco' from great depths (3000 to 4000 m.). Some forms occur from 40 to over 3000 m. Most of them grow out of the ooze and other bottom deposits; some are attached to dead pieces of other corals, such as *Lophohelia*. The soft parts are mostly rusty brown or black. The polyps mostly feed on the rain of debris and dead animals of small size. Some seem to grapple passing animals, for in the cœlenteron of *Stephanotrochus nobilis* Gravier found fragments of Ophiuroids and the tips of chelæ belonging to a Crustacean of considerable size. He remarks on associations of different kinds of corals, e.g. *Caryophyllia clavus* Scacchi, *C. arcuata* Milne-Edwards and Haime, and *Solenosmilia variabilis* Duncan. A well-known case is the association of *Desmophyllum crista galli* Milne-Edwards and Haime with *Amphihelia oculata* L. and *Lophohelia prolifera* (Pallas). The significance of the associations is not known. Attention is directed to the occasional tendency to constrict the opening of the calyx. The great majority of the abyssal Madrepores are solitary forms.

Fresh-water Medusoid from Limpopo River System.§—G. Arnold and C. L. Boulenger add to our previous knowledge of *Limnocnida rhodesiæ* Boulenger. The specimens were obtained from the Norquane River, a minor tributary of the Limpopo. They varied from 6 to 16 mm. in diameter. They were very transparent, but the tentacles were milky-white and the umbrella edge and the base of the manubrium were yellowish-white. They move at the rate of 12 to 14 in. per minute, and the manubrium seems to help. They preferred the cooler water of the deeper pools. They were not attacked by fishes. No traces of a hydroid stage were found.

* Biol. Results Fishing Experiments by F.I.S. 'Endeavour,' iii. (1915) pp. 61–94 (9 pls.).

† Mem. and Proc. Manchester Lit. Phil. Soc., lix. (1915) pp. 1–26 (2 pls.).

‡ Comptes Rendus, clx. (1915) pp. 380–2.

§ Proc. Zool. Soc. London, 1915, pp. 71–6 (1 pl. and 2 figs.).

The mouth can be completely closed. The gonads were poorly developed in all the specimens, most of which seemed to be males. The tentacles varied from 85 to 110. The nettle-ring is comparatively narrow, but is thickened and folded round the bases of the tentacles, the thickenings resembling the tentacle-buds of other Medusoids. In an individual with 96 tentacles, 84 sense-organs were counted—a pair at the base of each of the larger tentacles near the velar margin of the nettle-ring, whilst a single sense-organ occurs in a similar position at the base of each of the other tentacles with the exception of the smallest, which are without these organs. The Medusoids were infested with a peritrichous infusorian (*Trichodina*).

Fresh-water Hydromedusoid.*—The late George du Plessis found in August 1912 a number of Medusoids in fresh-water near St. Raphaël. They occurred in a lagoon of clear water (called le petit Argens), communicating with the Argus, a stream which enters the sea opposite Frejus. The smallest were of the size of a pin's-head; the sexual adults as large as a "dix-sous" piece. Du Plessis referred them to the genus *Laodice*, which is represented in the Mediterranean by several littoral species.

The winter is spent attached to green Algæ; the free life begins in April. The ovaries lie along the radial canals. The fertilized ova give rise to ciliated planulæ, and these become in a few hours very minute hydroid polyps, which may be sedentary or may float at the surface of the water.

The polypoid form remains single without forming a colony. It has irregularly disposed tentacles. In two or three days it buds off minute medusoids with four tentacles. These medusoids grow and increase the number of their tentacles, become sexual, and liberate planulæ. It is to be regretted that the observations made by Du Plessis were not left in a form available for publication.

Porifera.

Gametogenesis of Grantia compressa.†—Arthur Dendy finds that this sponge is hermaphrodrite, producing ova and spermatozoa simultaneously, but that the spermatozoa are produced in comparatively small numbers, the minute sperm-morulæ being scattered here and there, enclosed in spermatocysts, between the collared cells of the chamber walls, and also occurring free in the flagellate chambers. The spermatogonia in these sperm-morulæ are extremely minute, and their mode of division was not observed. Apparently they are sometimes transferred as sperm-morulæ to the inhalant canals of the same or of another individual, where they break up into spermatozoa, but it is probable that they may sometimes break up into spermatozoa before leaving the parent sponge. The evidence on these points is, however, curiously scanty, and it seems that the spermatozoa are rarely, if ever, liberated in large numbers. The evidence goes to show that *Grantia compressa* is normally

* Procès-Verbaux Soc. Vaud. Sci. Nat., l. (1914) pp. 62–3.
† Quart. Journ. Micr. Sci., lx. (1914) pp. 313–76 (4 pls.).

an annual sponge. According to Orton, there are two breeding seasons at Plymouth. In June embryos are discharged from large specimens (which subsequently disintegrate). These embryos develop into individuals which, while still very small, produce numerous embryos in October.

There can be no doubt that the tissues of sponges are much less definite and less permanent than those of typical Metazoa. The individual cells often exhibit a remarkable power of changing their relative positions and also a high degree of polymorphism. Any of the constituent cells of *Grantia compressa* may become amœboid and wander off to some new situation. Collared or pavement epithelial cells may become amœboid.

The primary oogonia appear to arise from collared cells, and to migrate from that layer into the mesoglœa. The collar and flagellum completely disappear and pseudopodia are put out. Before entering upon mitosis they are seen as rounded cells with slightly granular cytoplasm, sometimes with a residue of reserve material in the form of polygonal granules, with a faintly reticulate nucleus, a very large and conspicuous nucleolus, and a thin nuclear membrane.

The oogonia exhibit mitosis, and during the progress of this they migrate, re-entering the layer of collared cells into the flagellate chambers, where the cell-division actually takes place. Before the oogonia of this second generation are formed the nucleolus is cast out. The details of the division are described. It seems almost certain that another oogonial division takes place in the flagellate chambers very shortly after the first one. Small oocytes result.

The oocytes have a period of growth in the flagellate chambers and a second in the mesoglœa between the chambers. In both there is a marked formation of chromidia or "yolk-nuclei" by extrusion of matter from the nucleolus. It is very probable that shortly after leaving the flagellate chambers and undergoing the process of chromidium-formation, the young oocyte exhibits the prophases of a mitosis which really belongs to the first maturation division. The young oocyte puts out long branching pseudopodia by means of which it attaches itself to the mesoglœal surface of the layer of collared cells. These pseudopodia may have a merely anchoring function, but they probably extract nutriment.

The oocyte continues to increase in size and the nucleus grows more rapidly than the cytoplasm. There is a notable "contraction stage," the cell rounding itself off. Thereafter feeding by means of nurse-cells begins, and after the oocyte has increased greatly long root-like pseudopodia are put out again. When it reaches a diameter of about 0·045 mm., the oocyte withdraws its pseudopodia and a large first polar body formed in a typical way. The number of chromosomes in each daughter group of the first maturation spindle seemed to be about eight or ten. The second polar body was not found, nor any hint of a reducing division.

The nurse-cells capture nutrient cells and bring them to the oocyte. The nurse-cells are apparently derived from small amœbocytes which occur scattered in the mesoglœa. Other amœbocytes feed voraciously on their own account, even entering the flagellate chambers and

apparently devouring young germ-cells. It is just possible that some of the large phagocytes are parasitic amœbæ.

A striking general fact is the close agreement between the oögenesis in this sponge and that in higher animals, and it may be supposed that all the essential processes of oogenesis already existed in pre-choano flagellate Protozoon ancestors common to sponges and Enterozoa.

Aphroceras cliarensis at Plymouth.*—Arthur Dendy notes the occurrence of *Aphroceras* (*Leucandra*) *cliarensis* at Wembury Bay near Plymouth. This small calcareous sponge is an addition to the marine fauna of Great Britain, and it is interesting that it should have been recently recorded by Miss Jane Stephens from Clare Island. The individuals are usually solitary and less than an inch in height; the form varies from slender to globular; the surface, when viewed under a pocket-lens, showed a glistening appearance due to the presence of gigantic oxea in the dermal cortex. This arrangement resembles species of *Ute*, but the canal system is typically leuconid. The most remarkable and constant specific character is the presence of enormous sabre-shaped apical rays in the gastral quadriradiates, sometimes reaching a length of 0·5 mm.

Symbiotic Sponges.†—N. Annandale, in dealing with associations of varying degrees of intimacy, describes a number of sponges which occur commonly on living shells of *Ostrea* and *Mytilus* in the harbour of Madras or in lagoons of brackish water on the east coast of India. From mussel-shells he obtained *Mycale ægagropila* (Johnston) var. *militaris* nov, *M. mytilorum* sp. n., *M. madraspatana* sp. n., and *Lissodendoryx balanophilus*, all of them encrusting forms. Common as a film on oyster-shells in brackish water and also on leaves is *Suberites aquæ-dulcioris* sp. n. In its form and method of growth this sponge approaches *Prosuberites* Topsent, but the possession of horizontal spicule-fibres distinguishes it.

Protozoa.

Periodic Reorganization in Paramecium.‡—Lorande Loss Woodruff and Rhoda Erdmann describe an interesting process, which they call endomixis in the life of *Paramecium aurelia*, a race of which has been kept for over seven years and through more than 4500 generations in a perfectly normal manner. The main facts are the following. 1. This infusorian can reproduce indefinitely without conjugation under favourable environmental conditions. The so-called life-cycle does not exist. 2. Minor periodic fluctuations (rhythms) occur in the rate of reproduction. 3. The rhythms are the obvious physiological expression of periodic internal phenomena. 4. The internal nuclear phenomena comprise the formation of a complete new nuclear apparatus of micronuclear origin. This is the endomixis. 5. The essential cytological difference between endomixis and conjugation is the absence of the third division

* Journ. Mar. Biol. Assoc., x. (1914) pp. 258–9.
† Records Indian Museum, x. (1914) pp. 149–58 (2 pls.).
‡ Journ. Exper. Zool., xvii. (1914) pp. 425–516 (4 pls. and 22 figs.).

which in conjugation forms the stationary and migratory micronuclei, and of necessity the non-formation of a syncaryon.

In the race reared without conjugation for seven years the endomixis has occurred frequently, on an average once each month. As conjugation has been successfully consummated by individuals removed from this culture, it is plain that both endomixis and conjugation are normal phenomena in the life of this same race.

It seems clear that this culture offers strong physiological evidence against the interpretation of either of the first two so-called reducing micronuclear divisions as actually being a chromosome-reducing division. Since the nuclear changes in endomixis and conjugation are fundamentally the same, except for the absence of the third micronuclear division in the former, it is justifiable to regard this third micronuclear division which occurs in conjugation as the one directly preparatory, from the standpoint of chromosome reduction and sexual phenomena, for the imminent accession of foreign chromatin in the form of the migratory micronucleus of the other conjugant.

Endomixis involves the disintegration and absorption of the old macronuclear and micronuclear material, and a re-organization. It thus affords the opportunity for molecular re-arrangement, and therefore may afford the opportunity for the origin of variations within a pure line. Jennings found in pure lines of *Paramecium* without conjugation evidence of variations about the mean. These might be due to re-arrangements effected in endomixis. Woodruff and Erdmann have not found variations in the structure or in the division-rate in their culture, but they point out that endomixis affords a field for the origin of such variations. It is conceivable that "heritable" variations may result from some rare re-combinations in endomixis.

Endomixis initiates a new rhythm in the life-history, i.e. a period of increased metabolic activity and therefore a reproductive activity; and since its fundamental morphological features are almost identical with those preliminary to the formation of the stationary and migratory micronuclei in conjugation, the fact lends strong support to the view that conjugation has a dynamic as well as a hereditary rôle. Jennings has emphasized the importance of conjugation in connexion with heredity and variation; Calkins has emphasized the dynamic aspect: both aspects are probably important.

The authors describe in detail the cytological changes in the re-organization process—the descending phase, the climax, and the ascending phase. We have referred only to the general result that the life of the *Paramecium* race can proceed indefinitely with endomixis under favourable environmental conditions—conjugation being unnecessary. "Senile degeneration and "physiological death" are not the inevitable result of continued reproduction without conjugation. The cell has an internal regulatory phenomenon, endomixis, which is self-sufficient for the indefinite life of the race.

Cycles and Rhythms in Paramecium.*—Gary N. Calkins refers to the work of Woodruff and Erdmann, and discusses the question of

* Amer. Nat., xlix. (1915) pp. 65-76.

"immortality." The pedigreed race was kept going for seven years, with a generally uniform division-rate, subject, however, to occasional and periodic fluctuations or rhythms. These correspond roughly to what Calkins has termed cycles, which end in depression periods and, unless stimulated, in death. In rhythms, however, Woodruff maintains that there is no evidence of depression. During the low periods of the division-rate rhythms there takes place, in *P. aurelia*, a complete nuclear re-organization (endomixis), after which there is renewed vigour.

The re-organization without conjugation is closely similar to that which follows conjugation, and Calkins points out that there cannot be a great difference in the syncaryon resulting from the union of two closely related individuals and the functional micronucleus which undergoes asexual endomixis. The terms asexual endomixis and sexual endomixis may serve to distinguish the process of intermingling during parthenogenesis and after conjugation, respectively. Asexual endomixis in *Paramecium* is parthenogenesis and nothing more.

Woodruff and Erdmann conclude from their observations that old age and natural death do not occur in *Paramecium*, and that the so-called cycle is non-existent. Calkins draws the opposite conclusion that the one apparent exception among pedigree races, to the rule of depression and natural death in the absence of conjugation or its equivalent, is now removed, and that Woodruff's culture is no more than a long series of cycles, meaning by a cycle a more or less periodic alternation of high and low vitality as measured by the division-rate. Woodruff's "rhythm" is the same as Calkins's "cycle."

Calkins concludes: (1) that conjugation or its equivalent has primarily the result, as Bütschli suggested, of offsetting and overcoming the progressive weakening of vitality in Infusorians; (2) that more or less definite cycles of vigour and depression, ending in natural death unless conjugation or its equivalent supervenes, are characteristic of all pedigreed races of Infusorians; (3) that physical "immortality" is true of *Paramecium* and other ciliates only in the same sense that it is true of Metazoa; and (4) that the protoplasm of *Paramecium* is subject to the same laws of physiological usury that apply to Metazoa, and undergoes phenomena which, in Metazoa, we call old age, ending in natural death unless conjugation, or its equivalent parthogenesis, saves the race.

Chromosomes in Opalina.*—Maynard M. Metcalf describes *Opalina antilliensis* sp. n. from the rectum of the large toad, *Bufo agua* of Jamaica. It is a binucleated much-flattened form, with spiral lines of cilia. There may be forty-eight lines of cilia at the anterior end, but the number varies with size. The nuclei are more nearly central than in most binucleated forms. In early stages of mitosis the long axes of the nuclei lie nearly transverse to the lines of cilia; later on they come to lie more nearly parallel to them

The author discusses the chromosomes in *Opalina*. They are particularly clear in the new species, where two distinct sets occur, one massive and the other granular. The massive chromosomes occur in

* Zool. Anzeig., xliv. (1914) pp. 533–41 (21 figs.).

various sizes and shapes. During the anaphase stages the several diverse chromosomes at one end of the nucleus correspond to chromosomes of the same size and form at the other end of the nucleus. There are no massive chromosomes in the multinucleate species, but there are coarse chromatin masses.

The granular chromosomes consist of lines of granules which are hardly larger, but stain more deeply, than the achromatic granules. The multinucleate and binucleate forms take equal and very similar care of the granular chromatin in mitosis, but they differ greatly in the attention paid to the massive chromatin in the division of the nuclei. The binucleate forms manipulate the chromatin masses as carefully as the granular chromosomes, dividing and distributing them as accurately, and retaining among them the characteristic diverse forms and sizes always recognizable in the massive chromosomes during the anaphases of mitosis. The multinucleate species, on the other hand, neglect the chromatin masses, making no provision for their division or for the presence of even approximately equal quantities of massive chromatin in the two daughter nuclei. In spring, in both the multinucleate and binucleate species, all the massive chromatin is thrown away, the granular chromosomes become more compact, and growth processes are at a low ebb, until the readjustments resulting from the sexual process are accomplished. Then new massive chromatin is formed from the granular chromatin, much as in *Paramecium* the trophic macronucleus arises from an originaly idiochromatic micronucleus. The difference in the care exercised by binucleate and multinucleate species in dividing the trophic massive chromatin is probably due to the less need for exact equivalence of trophic qualities between the nuclei of forms which for all but a week or so in the year live in a multinucleate condition.

Infusorian Parasitic on Fresh-water Medusoid.*—G. Arnold and C. L. Boulenger report that a peritrichous Infusorian of the genus *Trichodina* was found in great abundance on the fresh-water Medusoid, *Limnocnida rhodesiæ* Boulenger, from the Norquane River. It occurred not only on the manubrium, but also on the velum, the tentacles, and the surface of the umbrella, sometimes in such numbers as to give the whole Medusoid a spotted appearance when viewed under the lens. Some were found inside the circular canal, and showed no signs of having been acted on by digestive juices. This suggests that *Trichodina* is able to lead an endoparasitic existence within the gastrovascular system. The Infusorian occurs also on *L. indica* and *L. tanganicæ*, so that it seems to be a common associate of fresh-water Medusoids, and must play much the same role with regard to these organisms as it does in the case of the species of *Hydra* in Britain.

Scissiparity in Peridinidæ.†—M. Pavillard discusses the phenomena of growth and scissiparity in the genus *Phalacroma*. Alongside of the normal individuals there are individuals of large size, and with inclusions which may be nutritive reserves. The increase in size is due to the

* Proc. Zool. Soc., London, 1915, p. 75.
† Comptes Rendus, clx. (1915) pp. 372–5 (2 figs.)

development of intercalary bands on each side of the meridional suture. These bands show the specific ornamentation. The formation of intercalary bands is a structural preparation for division, and the bands are transitory protective screens, which are got rid of when division occurs. The division restores the typical form of individual. Some systematic consequences of this interpretation are noted. Thus *P. vastum* is the megacytic form of a species, the normal types of which are represented by the so-called *acuta* variety of *P. vastum*.

Upper Silurian Foraminifera of Gothland.*—John Smith reports on a collection including several new species of *Hyperammina*, *Webbina*, *Lagena* and *Nodosaria*. Twenty-nine species are recorded, of which ten are new. Thirteen of the twenty-nine species are also recent, and all the Cambrian species (eleven) are still extant.

Leishmaniosis of Dogs.†—A. Laveran has studied the natural leishmaniosis of dogs which has been observed in all the regions where Mediterranean kala-azar is endemic. It is symptomatically and otherwise closely allied to the leishmaniosis which is readily produced by inoculating dogs with *Leishmania infantum*. The author discusses the relationships between *L. tropica*, *L. donovani* and *L. infantum*, asking, for instance, whether *L. tropica* may not be a variety of one of the others.

Schizogony in Sarcocystis muris.‡—Rhoda Erdmann finds that small amœboid and schizogonic forms appear in the intestine six days after infection. These small schizogonic forms ($0 \cdot 3 - 0 \cdot 4\ \mu$) consist of a minute protoplasmic body with a karyosome nucleus, and arise from smaller amœboid organisms which show typical schizogony.

* Ann. Nat. Hist., xv. (1915) pp. 301-9 (1 pl.).
† Ann. Inst Pasteur, xxix. (1915) pp. 71-104 (2 pls.)
‡ Proc. Soc. Exper. Biol., xi. (1914) pp. 152-3.

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Structure and Development.

Vegetative.

Evolution of Eucalyptus.*—C. Hall has studied the cotyledons of a number of species of *Eucalyptus* in special relation to the evolution of the genus. The results of the author's investigations confirm those obtained by Baker and Smith as the result of chemical and botanical research. The Corymbosas must be regarded as the most primitive group, and they were derived from an ancestor having comparatively large entire reniform cotyledons. Necessity for adaptation to environment brought about reduction of leaf-surface, as seen in *E. trachyphloia* and other species. The Stringybarks appear to have arisen as an offshoot from the Corymbosas, and owing to similar causes developed small cotyledons and hairy primary leaves. The origin of emargination is difficult to trace, but *E. Planchoniana* and *E. marginata* may represent descendants of the earlier examples. The cotyledons and primary leaves of the former point to its being a transition form to the Peppermints and their allies. The emarginate *globulus* type is usually accompanied by reduction in size of the cotyledon, but in West Australia the exceptional dryness of habitat has brought about a specially adapted, deeply bifid form of cotyledon, which has now spread to South and East Australia. Change in the form of cotyledon has been accompanied by change in essential oils. The *corymbosa* type of cotyledon is associated with pinene oil without eucalyptol. The members of the Peppermint group contain eucalyptol, phellandrene, and piperitone in varying proportions. The *globulus* type is characterized by eucalyptol-pinene oil, and in the more reduced types aromadendral. The bifid cotyledon is found associated with eucalyptol, pinene, and aromadendral. Finally, the author points out the great importance of *Eucalyptus* in the study of evolution, since so many of its connecting links appear to have survived, and it is now possible to trace the important part played by the cotyledon.

Growth-studies in White or Weymouth Pine (Pinus Strobus).†—H. P. Brown, who has previously studied the growth of a hard pine, *Pinus rigida*, now gives the results of his study of a soft pine, *P. Strobus*. He finds that the winter condition of the secondary cortex and cambium is similar to that of *P. rigida*. The marked differences which occur

* Proc. Linn. Soc. New South Wales, 1914, pp. 473–532 (32 pls.).

† Bot. Gaz., lix. (1915) pp. 197–241 (2 pls.).

between the mature bark of the two species are occasioned by changes which take place in the outer cortex (periderm). The cambium varies both in number of cell-layers (two to ten) and thickness in different parts of a tree. It is smallest in both these respects in the twigs and young branches, and increases gradually in dimensions from the apex downward, until that point is reached in the bole where the last annual ring is the thickest. Thereafter, the decrease in the diameter is not proportional to the falling off in the diameter of the last formed ring. Phloem development continues until late in the autumn, much longer than xylem development. Sieve-tubes in all stages of formation occur between cambium and fully formed phloem. The seasonal growth of phloem exhibits little or no compression as late as October 1. Subsequently contraction occurs, due to the extreme cold temperatures of winter. All the seasonal growth of phloem is crushed with the exception of the last six or eight transitional tracheids. Compression is greater in the crown than below. The processes of primar thickening and secondary thickening overlap, and both may be going on in closely neighbouring spots in the tree at the same time.

Growth in white pine is divisible into (*a*) growth without cell-division, and (*b*) growth with cell-division. The first begins as early as March, and the elements concerned (phloem) increase in radial diameter from 50 to over 100 p.c. The awakening of growth is due apparently to the rise of soil-water with an accompanying increase of temperature.

Growth by cell-division begins during the last half of April. At the start it is very rapid, and more elements are formed at the inside of the cambium than at the outside. The formation of new xylem elements follows the same order as in *P. rigida*, that is, it begins first in the bole at some distance below the apical shoot, and spreads upward and downward. As a result growth at the base of a tree may begin several weeks later than in the crown. The awakening and rapidity of growth is dependent on three factors:—moisture, available reserve food, and temperature. The first two are at an optimum in the spring; the amount of growth therefore is directly proportional to prevailing temperatures. The intensity of growth is a variable factor which changes from day to day, and even within a single day. Two periodic optimums of growth intensity occur, one during May and early June, the second in July and August. These vary from time to time at a given height in the tree and follow no definite law. The amount of growth at a definite time and place in the tree is equal to the sum of the prevailing growth intensities by the time each was in force. It is very irregular at different heights in the tree, but the cambium tends to even up discrepancies as the season progresses. The irregularities of growth are manifested not only in the actual dimensions of the newly formed tissues, but also in the xylem elements. Wide discrepancies may occur in closely neighbouring trees; in general, larger differences may be expected the greater the disparity in age. Growth is first retarded in the upper portions of the tree; it may continue vigorously below for some weeks longer.

Xylem formation goes on very sluggishly in all parts of the tree (the

terminal leader excepted) until late September and early October; phloem development as long as temperature permits. The total growth of white pine extends over a period of five and a half months, growth by cell-division between four and five months. Late wood formation begins during the first half of August: it is associated with a decrease in growth intensity, and begins first in the higher parts of the tree. Elongation of new shoots and leaves is simultaneous and begins in early May; it manifests itself only after xylem formation has begun. Growth in length in the shoots ceases about July 1; needle-growth may continue until August 15, or even later.

White pine has long roots and short roots. Only the first elongate to any extent, and often are in symbiosis with mycorhiza. Growth in length begins during the last half of April, in some cases even earlier; no reliable data were obtained regarding its cessation. Secondary growth occurs during the first season and proceeds in the usual way.

General.

Plant-Relationships.* — W. Magnus reviews and criticizes a series of papers by C. Mez and his pupils K. Golilke and L. Lange, dealing with the relationships of plants, as determined by serum-reactions. The first paper deals with the Angiosperms, the second with plants in general, and the third with the Ranales. In his examination of the methods and results Magnus points out that while the conglutination tests are suitable in some respects, they have many sources of error, especially in the presence of variable amounts of albumin, such as are found in the seed-extracts used. Moreover, the investigators' methods of obtaining concentrated solutions are faulty, and they have omitted to state the percentages of the solutions. Previous investigations have shown that it is unwise to assume that species are not related, even when certain reactions fail, so that the results of the present papers must be accepted with great reservation. Thus, the authors claim that the Cruciferæ and Papaveraceæ are not related since they do not give the same reaction with a particular serum, a conclusion which appears to be without justification. The unreliability of serum-reactions is also shown by the conclusion that the Cucurbitaceæ and Saxifragaceæ are closely related. The results of such reactions should be regarded as general Dicotyledon reactions. In several instances the results obtained by Lange with the präzipitin-methods are contradicted by those obtained with the conglutination-methods, but it is probable that this is due to the action of bacteria. This author seeks to prove that the Alismaceæ originate from the Magnoliaceæ because *Alisma Plantago* reacts with the serum of the Magnoliaceæ, but it is not shown that *Butomus*, which is more typical, gives the same reaction. It is also claimed that there is no connexion between the Berberidaceæ and the Nymphæaceæ, but that *Podophyllum* and *Nymphea* are closely related. The reactions confirm the relationship of the Leguminosæ, Rosaceæ and Ranunculaceæ. Unfortunately the conclusions are frequently based upon reactions with

* Zeitschr. Bot., lx. (1914) pp. 849–54.

only one genus, while many of the most important reactions give no result, so that the numerous assertions as to relationships have no scientific value. Especially are we doubtful of such results as the relationship of the Pinaceæ to the Magnoliaceæ on the one hand and to the Selaginaceæ on the other. Further investigation of this character may be awaited with interest, but their results will have more value if attention is confined to small groups of nearly related species and to well-defined reactions.

CRYPTOGAMS.

Pteridophyta.

(By A. Gepp, M.A. F.L.S.)

Structure and Affinities of Macroglossum Alidæ.*—D. H. Campbell discusses the structure and affinities of *Macroglossum* Copeland (1909), a fern of new generic type. His summary states that:—1. The genus contains two species, *M. Alidæ*, found in Sarawak, Borneo, and *M. Smithii*, growing in Buitenzorg Botanic Garden, but of unknown origin. 2. When mature, *M. Alidæ* is as large as *Angiopteris*, with leaves 4 m. long, but differs in habit, with its numerous, upright, simply pinnate fronds, and in its elongate, partly immersed, sori. 3. The gametophyte is much as in *Angiopteris*. 4. The antheridia are both dorsal and ventral, with more numerous sperm-cells and small spermatozoids. 5. The archegonia are as in *Angiopteris*. 6. The embryo has a conspicuous suspensor, as in *Danæa*. 7. The development of the embryo is as in other Marattiaceæ. The apical cell is not always evident. 8. The young sporophyte has no true cauline stele, but leaf-traces only. 9. The structure of the axis is intermediate between *Danæa* and *Angiopteris*. 10. The cotyledon is as in *Angiopteris*: the first leaves, about ten, remain simple. Stipules first appear in the third leaf. The first leaf-trace shows a collateral structure. 11. The primary root is usually diarch, and has a single initial cell. A single root is formed for each of the early leaves. 12. The leaf of the adult sporophyte is simply pinnate, and the anatomy of the leaflets is different from that in *Angiopteris*. There is a conspicuous mucilage duct below the sorus, and a better developed palisade tissue. 13. The sporangia of *Macroglossum*, especially *M. Alidæ*, are smaller than those of *Angiopteris*, and very much more numerous. The sorus is more compact, and partially sunk in a trough formed by elevated ridges between the sori, while in *Angiopteris* no such ridges are present. The annulus is very slightly developed in *Macroglossum*, and the indusial hairs very much more conspicuous than in *Angiopteris*. 14. The roots of the adult plant have no mucilage ducts, thus differing from the other Marattiaceæ. 15. *Macroglossum* should undoubtedly be placed in the Angiopterideæ, but its affinities are with *Archangiopteris* rather than with *Angiopteris*. *M. Alidæ* is farther removed than *M. Smithii* from *Angiopteris*.

* Ann. Bot., xxviii. (1914) pp. 651–69 (3 pls. and figs.).

Anatomy of Cheilanthes and Pellæa.*—A. S. Marsh has made an anatomical study of certain xerophilous species of *Cheilanthes* and *Pellæa* :—1. The xerophilous species of these genera show well-marked leaf adaptations—such as hairs or scales on the lower surface, inrolled margins, thick cuticle, and palisade parenchyma. 2. The *Cheilanthes* species, all belonging to the section *Physapteris*, show a wide range of stelar anatomy in their stems. Details of these are given. 3. In *Pellæa* one xerophytic species was examined, *P. andromedæfolia*. 4. The petiolar structure, the stem anatomy, and the greater output of spores per sporangium all point to *C. Fendleri* as a near approximation to an ancestral type from which *C. gracillima* and *C. lanuginosa* have been derived.

Anatomy of Helminthostachys.†—W. H. Lang publishes a detailed paper on the anatomy and branching of the rhizome of *Helminthostachys zeylanica*. His long summary is difficult to compress :—1. The rhizome of *Helminthostachys* exhibits a general segmental construction—two dorso-lateral and one ventral segment. The former correspond with the leaf-insertions. The ventral segments bear no leaves. Internodes are not evident in the adult plant. The relation between segmental construction of the rhizome and cell-segmentation at the apex is not traced out. 2. The stele of the adult rhizome has a large pith in a tube of mesarch xylem. 3. The roots are endogenous and penetrate a thin cortex. Their xylem is continuous with the outer xylem of the rhizome stele, and sometimes the pith is also continuous. 4. The dorsal side of the stele is disturbed by the leaf-traces and in relation to the vestigial buds. The leaf-trace exhibits considerable variety in its mode of departure, structure, and mode of division in the cortex. For instance, whether mesarch or endarch, the leaf-trace may divide into two in the cortex without adaxial completion of the outer xylem or the other tissues ; but more usually it is complete before division. 5. The disturbance of the stele in relation to the vestigial axillary buds varies in degree, being most marked in large adult rhizomes. In all cases the endodermis remains open ; and there may be a bulge of xylem behind the bud. The vestigial bud is in relation to the subtending leaf, and is somewhat variably situated relatively to the leaf-gap. 6. The vascular relations of two branches, developed from lateral buds, to their parent rhizomes are described, and place the nature of the dormant buds beyond doubt. 7. The inner xylem is unequally developed at different levels in the adult rhizome, and exhibits a gentle rhythm of decrease and increase in the dorsal region of the stele. It diminishes or disappears opposite the nascent leaf-trace, and is very strongly developed as the leaf-gap closes. 8. The structure of slender rhizomes with the juvenile type of stele, is described both for plants developed from the embryo and for branches. 9. The juvenile type of anatomy may be maintained for many nodes. The transition from the seedling structure to the adult type has not been studied. 10. The juvenile type of structure is

* Ann. Bot., xxviii. (1914) pp. 671–84 (figs.).
† Ann. Bot., xxix. (1915) pp. 1–54 (3 pls. and figs.).

to be regarded as an expression in miniature of what is found in full-sized rhizomes, and is to be explained on physiological, rather than on phylogenetic, grounds. 11. The segmental construction of the rhizome is more or less clearly reflected in the stelar anatomy. 12. Comparisons are made with the Zygopterideæ and Cycadofilices as regards the outer and inner xylems, the secondary thickening, the peculiarities of the leaf-trace, and the nature of the branching, and confirm the general view of a relationship between the Ophioglossaceæ and the more primitive ferns.

Rhizome of Platycerium.*—Miss Harriet E. Allison gives a detailed and illustrated account of the vascular anatomy of the rhizome of *Platycerium*, and finds that it suggests a comparison with the Marattiaceæ and Pterideæ. Most likely *Platycerium* is related to the Matonineæ. Diels placed it near *Cheiropleuria*; and Christ groups these closely with *Dipteris*. But anatomically *Dipteris* is relatively simple; its simple solenostele is replaced by several concentric solenostelic cylinders in *Matonia*. *Platycerium* might be regarded as the dictyostelic type of a series of which *Dipteris* and *Matonia* are the solenostelic types. And possibly facts other than anatomical may be discovered to support the supposition that *Platycerium* is more or less allied to the *Dipteris-Matonia* series.

Morphology of Isoëtes.†—W. H. Lang has been studying the morphology of *Isoëtes*, and gives an account of the general structure of the stock of *Isoëtes lacustris*. In summing up his results he states that it consists of a shoot-region and a rhizophoric-region. The origin of the rhizophore may perhaps stand in some relation to the deep-seated secondary meristem at the base of the shoot. Once initiated, however, the growing region of the rhizophore behaves like a primary apex which is congenitally sunken and enclosed. This apex is extended as a line in two-lobed forms, and in three or four directions in three or four-lobed stocks. It gives rise to roots in acropetal order, and these when mature stand exogenously on the surface, which is exposed by the split. On this general view (which allows for the conflicting facts emphasized in Von Mohl's and Hofmeister's explanations respectively, and confirms Williamson's comparison with the organization of the Lepidodendreæ), some details of the stock of *Isoëtes* will be further investigated by the author.

Vegetative Reproduction in Selaginella.‡—Miss N. Bancroft has investigated the reproductive tubers in two Indian species, *Selaginella chrysocaulos* and *S. chrysorrhizos*. The tubers are fundamentally similar, though differing for physiological reasons owing to difference of position on the plant. In *S. chrysocaulos* they occur at the ends of ordinary

* New Phytologist, xii. (1913) pp. 311–21.

† Mem. and Proc. Manchester Lit. and Phil. Soc., lix. (1915) No. 3, pp. 1–28 (figs.).

‡ Ann. Bot., xxviii. (1914) pp. 685–93 (1 pl. and figs.).

vegetative branches and remain at the surface of the ground; in *S. chrysorrhizos* they are developed underground at the ends of filamentous, modified vegetative branches. In the former case, the leaves of these tubers or buds are densely chlorophyllose: in the latter they are scale-like, without chlorophyll, and packed with reserve-material. Further, in *S. chrysocaulos* the ventral rhizophores alone are functional, while the dorsal ones remain functionless and but little developed; in *S. chrysorrhizos* both kinds of rhizophores are functional but remain very short, the tubers being already buried in the soil.

Apogamy in Nephrodium hirtipes.*—W. N. Steil gives an account of the prothallia obtained by artificial cultivation from the spores of *Nephrodium hirtipes*. No archegonia were observed, but embryos of apogamous origin were found in the earliest stages. Light areas were seen just behind the apical notch. In these areas appeared first tracheids, then a compact mass of cells, which developed into the apogamous embryo. A foot was never formed. The primary leaf was formed, then the primary root, and later the stem. Such was the usual course of development. In this species also cell and nuclear fusions were discovered in the sporangia, similar to those found in *Aspidium falcatum* by Ruth Allen. The 16-spore mother-cells fused in pairs, and then divided up into 32 spores—often reduced by irregularities of development.

Ferns of Madeira.†—C. A. de Menezes includes in his Flora do Archipelago da Madeira a list of the fifty ferns hitherto recorded as occurring in the islands of Madeira and Porto Santo, with some descriptive notes as to structure, native names, literature, localities, etc. An interesting list of botanists, who have made collections in Madeira, is supplied.

Hawaiian Ferns.‡—E. B. Copeland publishes a paper on Hawaiian ferns collected by Abbé Faurie in 1909–10. The ferns of Hawaii have been thoroughly studied by W. J. Hillebrand,§ and a further account of them has been given by W. J. Robinson.‖ The isolated position of the archipelago has led to the production of a peculiar endemic flora. The species of *Diella* and *Sadleria* have evidently all been developed locally in each genus from a common ancestor, which can be indicated almost with certainty. A similar development has occurred in *Asplenium*, from several immigrant ancestral forms, and the descendants overlap perplexingly. Three cosmopolitan species are now added to the flora; and seven species new to science are described.

* Bot. Gaz., lix. (1915) pp. 254–5.
† Funchal: Typ. Bazar do Povo, 1914, pp. 202–12.
‡ Philippine Journ. Sci., ix. Sect. C (1914) pp. 435–41.
§ Flora of Hawaii, 1888.
‖ Bull. Torrey Bot. Club, xl. (1913).

Bryophyta.

(By A. Gepp.)

Morphology of West Himalayan Liverworts.*—S. R. Kashyap publishes morphological and biological notes on new and little-known West Himalayan liverworts. 1. *Exormotheca tuberifera* is a new species which differs from other members of the genus in three ways:—The scales have no appendages. The plants form apical and particularly ventral tubers. The female receptacle has stomata. 2. *Stephensoniella brevipedunculata* is a new genus and species related to *Exormotheca*, but differing in its simpler sporogonium, empty air-chambers, and above all in the continuation of growth after the formation of the female receptacle. It also resembles *Boschia* and *Corsinia* in several features. 3. Note on *Plagiochasma appendiculatum* L. et L. 4. *P. articulatum* is a new species remarkable in that both the male and the female receptacles are terminal at first, and not dorsal outgrowths as in other species of *Plagiochasma*.

Continuing his studies, he gives an account† of the following:—*Cryptomitrium himalayense*, *Fossombronia himalayensis*, *Sewardiella tubifera*, *Anthoceros himalayensis*, *A. erectus*. These are all new to science, and *Sewardiella* is a new genus closely related to *Fossombronia*. He gives an account also of *Athalamia pinguis* Falc. and *Gollaniella pusilla* Steph.

Reduction in the Marchantiales consists in the development of the thallus at the expense of the sex organs. This occurs in two ways—either (1) by a decrease in the number of branches of the female receptacle together with elimination of the stalk as in *Exormotheca*, *Aitchisoniella* and *Targionia*; or (2) by a decreased number of archegonia in each involucre, as in Astroporæ and Operculatæ. The object of this development of the vegetative thallus is the resistance to drought.

Rare European Mosses.‡—G. Roth publishes descriptions and figures of some new or little known European mosses:—*Hymenostomum Meylani* Amann (Switzerland); *Pohlia torrentium* Roth (Norway); *Bryum* (*Eubryum*) *sarekense* Arn. and Jens. (Sweden); *B. Payoti* Schimp. (Savoy); *B. crispulum* Hampe (Sweden); *B. Rechini* Card. (Savoy); *Drepanocladus aduncus* var. *tenerrimus* Roth and V. Bock (Livland); *D. capillifolius* var. *pseudo-Sendtneri* Roth and V. Bock, and var. *robustus* Roth and V. Bock (Livland); *D. serratus* var. *crassinervis* Roth and Röll (Unterpörlitz); *Scleropodium ornellanum* Mol. (Lombardy); *Limnobium lusitanicum* Roth (Portugal).

Mosses of Madeira and Teneriffe.§—H. Winter publishes an account of the mosses of Madeira and Teneriffe, the result of a visit made in March to May, 1912. Obviously the complete moss-flora of

* New Phytologist, xiii. (1914) pp. 308–23 (8 figs.).
† New Phytologist, xiv. (1915) pp. 1–18 (figs.).
‡ Hedwigia, lv. (1914) pp. 148–56 (1 pl.).
§ Hedwigia, lv. (1914) pp. 82–144 (figs.).

the islands is as yet unknown: for Winter succeeded in finding eleven new species and eight varieties, which he describes and figures, as well as eleven species already described but not known to occur in the islands.

New American Fossil Moss.*—Elizabeth G. Britton and A. Hollick publish a diagnosis of a new fossil moss found in 1875 by S. H. Scudder in the Tertiary (Miocene) shales of Florissant, Colorado. It is named *Plagiopodopsis Scudderi*, from its general resemblance to *Plagiopus Oederi* Limpr., of the Bartramiaceæ.

West Indian Mosses.†—Elizabeth G. Britton publishes an account of 28 mosses, collected in the Danish West Indies and Virgin Islands by herself and others, including Brentel's collection (1841). She gives diagnoses of three novelties—*Hyophila uliginosa*, *Phascum sessile*, *Bryum microdecurrens*—and also of *B. Cruegeri* Hampe.

Australasian Mosses.‡—H. N. Dixon publishes descriptions and figures of some new and rare Australasian mosses, mostly from W. Mitten's herbarium. The following species are new: *Dicranoloma angustiflorum* from Tasmania, and the rest from New Zealand: *Dicranum aucklandicum*, *Didymodon calycinus*, *Cinclidotus australis*, *Macromitrium Petriei*, *Pohlia novæ-seelandiæ*, *Anomobryum densum*, *Philonotis australis* var. *surculigera*, *Thamnium baculiferum*, *T. latifolium* var. *elongatum*, *Pterygophyllum distichophylloides*, *Rhynchostegium cylindritheca*. A description of the perichætium and fruit of *Taxithelium polystictum* is given: and the characters of the difficult group—*Macromitrium erosulum* and its allies—are critically discussed.

Cratoneuron filicinum.§—L. Dietzow discusses the systematic position of *Cratoneuron filicinum*, which is shifted about by authors between that genus and *Hygroamblystegium*. Dietzow considers that it should be definitely accepted as a *Cratoneuron*. As further confirmation of this view he instances the variety *verrucosa* Dietz. with the warty protuberances on the leaves, the extreme forms of which are f. *scabrida* and f. *pseudopapillosa*. These forms are regarded as parallels with *C. decipiens*, although the author himself emphasizes the fact that this species has sharp-pointed papillæ. Finally, the author inveighs against the habit of making a "variety" out of every slight variation of a species. Such variations of habit deserve only the name of "form." A "variety" demands a distinct anatomical characteristic which may be determined with certainty.

Lepidozia sylvatica in Britain.‖—W. E. Nicholson publishes an account of the North American hepatic *Lepidozia sylvatica* Evans, which

* Bull. Torrey Bot. Club, xlii. (1915) pp. 9–10 (figs.).
† Bull. Torrey Bot. Club, xlii. (1915) pp. 1–8 (1 pl.).
‡ Bull. Torrey Bot. Club, xlii. (1915) pp. 93–110 (1 pl.).
§ Hedwigia, lv. (1914) pp. 277–9. See also Bot. Centralbl., cxxviii. (1915) p. 50.
‖ Journ. Bot., liii. (1915) pp. 88–90.

has been recorded as occurring in Europe, and which he has now succeeded in finding in Sussex. He came upon a few old, but perfect, perianths which place the identification beyond dispute. He supplies a diagnosis of the species and adds critical notes. The British species of the section *Microlepidozia*: *L. setacea*, *L. trichoclados* and *L. sylvatica*, are very closely allied, and might be regarded as three fairly constant races of one species adapted to their several environments, which are respectively Sphagnum bogs, peat, and sandy ground or rocks. He indicates points of structure by which the three species may be separated; and believes that all Sussex plants of *L. trichoclados* will be found to belong to *L. sylvatica*; but, in the absence of perianths, proof is difficult.

Mosses of West Highlands.*—J. Stirton discusses the presence of certain globular hyaline cells observed in leaf-sections of a specimen of *Leucobryum albidum* from Loch Tay. These cells measure 16–25 μ, and were observed within the large quadrate cells. He also discusses the structure of two mosses determined by Fergusson years ago as *Andreæa obovata* Thed., from Glen Callater, and *Grimmia robusta* Ferg. The former he regards as having closer affinities with *A. obovata* than with *A. alpina*, to which it has been usually referred as a mere stunted form. As to *Grimmia robusta*, placed by some bryologists under *G. Schultzii* Schimp. as a mere variety, he points out the differences of structure which lead him to consider *G. robusta* to be a well-defined species. Finally, he gives a diagnosis of *Bryum perpusillum*, a new species from Gairloch, one of a group of minute species discovered by himself—the others being *B. Stirtoni* Schimp., *B. leptaleum* Stirt., *B. tenerrimum* Stirt., *B. elegantulum* Stirt. None of the five has yet been found in fruit.

Critical Revision of Carl Müller's Moss Genera.†—M. Fleischer has undertaken the task of working out the Carl Müller herbarium of mosses according to modern views. In the present paper he publishes a critical list, containing two opposite rows of names. On the left are the names of species of *Cryphæa*, *Dendropogon* and some *Alsia* found in the herbarium; on the right are the modern names, or the new combinations made by the author. Of the Müller Cryphæae, numbering seventy-two, twenty-seven species are here transferred to eight other genera, two of these being new. One of them, *Sphærotheciella*, is allied to *Pilotrichopsis*, but differs from it in habit and also by having a globular sporogonium with large many-celled spores. The species *S. sphærocarpa* Fleischer comes from Sikkim, and according to Fleischer the genus *Cryphæa* does not occur in the Himalayas.

* Glasgow Naturalist, vi. (1914) pp 33–9.
† Hedwigia, lv. (1914) pp. 280–5. See also Bot. Centralbl., cxxviii. (1915) p. 51.

Thallophyta.

Algæ.

(By Mrs. E. S. Gepp.)

Symbiosis of Bacteria and Flagellates with Cyanophyceæ.*—A. Tascher follows up the work of Bader on the symbiosis of a bacterium, *Chloronium*, with a cyanophyceous organism, by describing similar cases. In two of these, lower blue-green algæ are associated with a bacterium, respectively *Bacterium* sp. and *Spirillum* sp. In the third case the association is with a monad. The author proposes for such associations the term Syncyanosis. The symbiosis does not go so far as that one of the symbionts loses its independence. The algæ were found in quantity in an independent state. Also in the case of the bacteriosyncyanosis, the death of the bacterium did not prevent a large reproduction of the blue-green algæ. The usefulness of the symbiosis, according to the author, is, for the bacterium or the monad, in the production of carbonic acid by the assimilating organism; for the algæ, perhaps in the absorption of decay products of the mucilaginous sheath. Cases of syncyanosis do not appear to the author to be radically different from the well-known associations of higher Cyanophyceæ with gelatinoid algæ. The author finally discusses two new associations of algæ with one another; an *Anabæna* with a small net-forming Chlorococcacea, and a green alga with a Chamæsiphonacea.

Water-blooms.†—R. Kolkwitz discusses water-blooms, and insists on the importance of quantitative examination. He records a number of quantitative results. *Oscillatoria Agardhii* was found in August, 1911, by the author in the Lietzensee in quantity about 20,000 filaments to 1 c.cm. of ladled-out water; in February and March, on the other hand, he found only 15–20 filaments in 1 c.cm. He also gives information about marine water-bloom. The development of water-bloom is dependent on temperature, and shows also a connexion with the richness of the water in organic substances. Those lakes which have yellow water, containing much humic constituents and substances with a nutritive value, such as the Havelseen, the Müggelsee and others, are much richer in plankton and water-bloom than the lakes with blue-green water, which is poor in organic substances, such as mountain lakes, the Lake of Geneva, etc.

Water-bloom of Gonium pectorale.‡—D. Plümecke had under observation a small aquarium in the open (1·25 m. × 1·00 m. × 0·40 m. deep), which contained several cm. of mud, and the water of which was

* Ber. Deutsch. Bot. Gesell., xxxii. (1914) p. 339. See also Bot. Centralbl., cxxviii. (1915) p. 50.

† Bot. Jahrb. Festb., 1914, pp. 349–56. See also Bot. Centralbl., cxxviii (1914) p. 502.

‡ Ber. Deutsch. Bot. Gesell., xxxii. (1914) pp. 131–6. See also Bot. Centralbl., cxxviii. (1914) p. 503.

rich in organic nutriment. For several weeks *Gonium pectorale* formed a water-bloom in which 300–400 colonies were present in 1 c.cm. of water. *Pandorina morum* and *Scenedesmus quadricauda* also occurred. Towards the end of November isolated growths of *Euglena viridis* were found, and *Gonium* was duly present in dividing colonies. *Pandorina* and *Scenedesmus* disappeared almost entirely. The author quotes publications by various authors to support his view that many Volvocaceæ are ready on certain occasions to absorb organic nutrition, and to develop luxuriantly.

Brandenburg Algæ.*—E. Lemmermann describes a new endophytic species of *Calothrix*, found by him among *Nostoc Linckia*, collected in Nieder-Lausitz. He calls it *C. marchica* and gives a figure of it.

Problems of a Modern Study of Plankton.†—V. Brehm publishes a sketch of a course of study at the Lunz fresh-water station in N. Austria. He gives first a history of the development of research in fresh-water plankton—Apstein's use of the Hensen methods, and Wesenberg's work. The author considers that future work in plankton will be characterized by problems of heredity, which are unapproachable from other sides. He describes in detail the views held by authors on the colour and form of various plankton units, and unfolds the latest theories on cyclomorphosis and cycles of generation. The work should interest botanists as well as zoologists.

Culture of a Plankton Diatom.‡—E. J. Allen records his experiments on the culture of the plankton diatom *Thalassiosira gravida* Cleve, in artificial sea-water. He shows that cultures in a purely artificial medium, though prepared according to the most accurate methods, were not successful. But if even less than 1 p.c. of natural sea-water were added to the artificial medium and the whole were sterilized, then the cultures obtained were excellent. These results seem to show that natural sea-water contains some specific substance, without which no vigorous growth of the diatom can take place. The experiments are described in detail.

Marine Plankton.§—G. Stiasny writes a general account of marine plankton. Plankton and nekton form together the living world of pelagic waters, and plankton stands in close connexion with benthon which inhabits the bottom of the sea. The method of life and the form of plankton algæ are based on adaptation to conditions of life, which causes greater variety in floating apparatus. In the plant world only few lines of descent can trace their origin to plankton, while in the

* Abh. Naturw. Ver. Bremen, xxiii. (1914) pp. 247–8. See also Bot. Centralbl., cxxviii. (1915) p. 7.

† Jahresb. k.k. Staatsgym. in Eger, Bohemia, 1913–14, pp. 1–20. See also Bot. Centralbl., cxxviii. (1915) p. 46.

‡ Journ. Mar. Biol. Assoc. United Kingdom, n.s. x. (1914) pp. 417–39. See also Bot. Centralbl., cxxviii. (1915) p. 46.

§ Schrift. Ver. Verbr. Naturw. Kenntn. Wien, liii. (1913) pp. 431–54. See also Bot. Centralbl., cxxviii. (1915) p. 47.

animal world all seven main lines are represented. All plankton forms strive so far as is possible to counteract the tendency to sink, and this is carried out in many different ways. The utility of plankton to mankind is mainly indirect.

British Flagellatæ.*—F. E. Fritsch, appreciating the many new and interesting Flagellatæ discovered in Continental fresh-waters by Klebs, Lemmermann, Pascher and others, has been led to investigate British waters more carefully, and in the first of a proposed series of papers publishes some of his results under the following headings:—1. *Isococcus sphagnicolus* nov. gen et sp. Volvocacearum. 2. *Chrysococcus tessellatus* sp. n. 3. On some forms of *Cryptomonas*. 4. On two species of *Lepocinclis* (Englenineæ). Besides the above novelties he describes also *Cryptomonas Richei* and *C. anomala*, and *Lepocinclis salina*.

Organisms of Manchester Water-Supply.†—C. Turner publishes an address delivered on the microscopy of the Manchester Water-Supply, and gives a list of organisms found in Manchester water, including desmids, diatoms, Chlorophyceæ, Cyanophyceæ and Peridinieæ. The records were made in September and October, 1913. Notes by E. Batty on the plankton of Manchester water in January to November, 1907, and January, 1908, are appended to the paper.

British Fresh-water Algæ.‡—G. S. West publishes a further series of algological notes as follows: XIV. Some species of the Volvocineæ—new records for Britain, including two species of *Chlamydomonas* new to science. XV. Observations on the structure and life-history of *Mesotænium caldariorum* Hansg. He found this very rare desmid in Wyre Forest, and describes his method of cultivating it subaërially, and tells of its structure, cell-division, conjugation, and of the germination of its zygospores; the family Mesotæniaceæ proposed by Oltmanns is of no value. XVI. Two new species of *Ulothrix*. XVII. The genus *Tetradesmus*. This was described by G. M. Smith in 1913, and forestalled *Victoriella*, created by Woloszynska in 1914. It belongs to Selenastreæ, a sub-family of Autosporaceæ. It is allied to *Ankistrodesmus*, and contains three species:—1. *Tetradesmus wisconsinensis* Smith, from North America and Norway. 2. *T. Ostenfeldi* Woloszynska, from Victoria Nyanza. 3. *T. cumbricus*, a new species from the plankton of Ennerdale Water.

Euglena oxyuris.§—L. B. Walton describes the process of cell-division and the formation of paramylon in *Euglena oxyuris* Schmarda. The various stages are described and figured, and the time occupied in the division of an individual was 6½ hours. The author considers that the time may vary according to surrounding conditions, especially temperature and nourishment. He describes a peculiar phenomenon in

* New Phytologist, xiii. (1914) pp. 341–52 (3 figs.).
† Manchester Micr. Soc., Ann. Rep. and Trans., 1913 (1914) pp. 44–58 (1 pl.).
‡ Journ. Bot., liii. (1915) pp. 73–84 (7 figs.).
§ Ohio Naturalist, xv. (1915) pp. 449–451 (1 fig.).

connexion with the two paramylon granules. At the time when longitudinal division was nearly complete, the protoplasm containing the granule of the individual on the left would rapidly flow posteriorly, so that the granule was actually in the posterior end of the individual on the right. This process took 20 seconds. Then the reverse flow occurred and the protoplasm containing the granule of the individual on the right would flow to the left. Observers could hardly refrain from fear that one individual would secure all the paramylon. The question as to the possible free-formation of paramylon as an assimilation product of the protoplasm has long been discussed, and is still undecided. The mode of formation of the anterior paramylon granule in *E. oxyuris* is extremely suggestive, however, that the result is due to the activities of the protoplasm quite independently of the numerous small chloroleucites present.

Algological Notes.*—E. Lemmermann publishes a critical study of the genus *Characiopsis* Borzi. He is of opinion that a number of species included in *Characium* should be transferred to *Characiopsis*, and that the genus therefore contains eighteen species and seven varieties. He gives references to literature and collections. Fourteen species are figured.

In another study he treats of algæ found in the filaments of *Utricularia*. Two specimens of *Diaptomus gracilis* van Douwe were found in two filaments of a Brazilian species of *Utricularia* by Dr. van Douwe. Other species in the same plant included two Flagellates, one Heterokont, three Protococcaceæ, and twenty-seven Conjugatæ, of which the author gives a list. How the algæ arrive in that position is still a matter of theory. Some of the species are figured.

New European Nitella.†—J. Groves publishes a description and figures of *Nitella Dixonii* H. and J. Groves, a new species found in the waters of Monchique in Algarve, Portugal, by H. N. Dixon in May, 1911. He adds critical notes on the structure of allied species of the group *Polyarthrodactylæ*, a group belonging mostly to the southern hemisphere. The finding of a new member of this group in Europe is of great interest.

New Fossil Alga.‡—H. Glück describes a new fossil species, *Microcodium elegans*, from the marine tertiary strata of South Germany. He discusses the various living species of *Codium*, and then describes the fossils collected in South Baden and the neighbourhood of Sigmaringen. The algæ are 0·2–2 mm. long; the small specimens are granular, the larger ones elongated, lumpy. Some of them show a symmetrically rayed arrangement of the external club-shaped, long cells; the smaller central part shows only regularly polygonal cells, on the whole like living species of *Codium*. The elongated palisade-cells have dark cell-contents.

* Abh. Naturw. Ver. Bremen, xxiii. (1914) pp. 249–67. See also Bot. Centralbl., cxxviii. (1915) p. 6.

† Journ. Bot., liii. (1915) pp. 41–3 (1 pl.).

‡ Mitt. Bad. Geol. Landesanstalt, vii. (1912) pp. 1–24 (4 pls.). See also Bot. Centralbl., cxxvi. (1914) pp. 553–4.

Reproductive organs are unknown. The algæ were probably attached species of a coastal region. The form is much smaller than that of living species.

Fossil Algæ.*—A. Rothpletz discusses, among other fossils, the calcareous algæ of Gottland. They are all encrusted species, belonging to different families, mostly to Siphonales. *Solenospora* is represented by four species, of which one is new. The other described species of the genus are criticized. A new genus, *Hedströmia*, is described; it is allied to *Halimeda* and contains two species. *Sphærocodium* is represented by several species. Then follows the *Siphoneæ verticillatæ*, in which again a new species is described. The author then discusses the formation of ooliths.

Swollen Cells in Antithamnion.†—B. Schussnig writes on the bladder-like cells of *Antithamnion*, which he agrees with Nestler in regarding as branches (Kurztriebe). As regards their function, he does not consider that they have any connexion with light, nor that they are storage cells. He regards them as floats. Their less dense contents point to this, also their hyaline appearance, and the brilliance which indicates high refraction. Glycerin caused no crumpling, which shows impermeability to sea-water. The author considers that the physical structure of the membrane of the bladder-like cells acts in the same way as the tissue of the bladders in *Sargassum*. Also he regards the position and frequency of these cells, as well as the thallus structure, as fitting in with his theory. Another point he makes is the great number of bladder-cells, which are associated with plentiful formation of tetraspores, thus lightening the otherwise heavy tetrasporic branch.

Ceramothamnion adriaticum.‡—B. Schussnig writes on the red alga *Ceramothamnion adriaticum* Schiller. It forms long filaments, which grow by means of an apical cell, dividing off its segments horizontally. Every joint of the main axis cuts off a number of cortical cells, so that the thallus resembles morphologically a simple *Ceramium*. Branching is rare, mainly adventitious, occasionally forked. The plants, which below throw out creeping shoots, form plentiful rhizoids. The protoplasm which lies against the wall of the axial cells contains elongated light pink lobed chromatophores. In the cortical cells the lobes appear broad. The tetraspore-mother-cell arises from a basal cell of a small cortical branchlet. As this process is often repeated in close proximity, it sometimes occurs that three tetrasporangia of different ages lie close together. The author found no other organs of reproduction. He regards the mode of cortication as well as the free position of the tetrasporangia as primitive characters, and considers that morphologically it

* Sver. Geol. Undersökn. Afhandl. och Uppsats, Stockholm, 1913, No. 10, 57 pp. (9 pls. and 1 map). See also Bot. Centralbl., cxxviii. (1915) p. 92.

† Oesterr. Bot. Zeitschr., 1914, pp. 1–8 (1 pl. and 4 text-figs.). See also Bot. Centralbl., cxxviii. (1914) p. 126.

‡ Oesterr. Bot. Zeitschr., 1914, pp. 85–93 (1 pl. and 3 figs. in text). See also Bot. Centralbl., cxxviii. (1914) p. 127.

adapted itself fairly early to ecological conditions. In springtime the alga is distributed all over the Adriatic, and is most frequently found on *Udotea Desfontainii*.

Development of Certain Florideæ.*—K. Killian describes his successful experiments on the cultivation of marine algæ, with a view to studying their development from the earliest stages. He used cement basins, into which fresh filtered sea-water was pumped day and night. Ceramiaceæ and other filamentous algæ could only thrive if no diatoms were present, and if the water had been passed through a Berkefield filter. The necessary ventilation was provided by Crustaceæ, Echinoderms and meat-eating fishes. The algal spores germinated on obliquely inclined object-glasses; and the cultures were so distributed in the aquarium as to realize natural conditions as much as possible. The sporelings were examined under the Microscope in flat glass vessels. It was mostly possible to follow the development for at least six months.

As regards the development of the vegetative organs, the author was enabled to establish the following results. The group of Ceramio-Rhodomeleæ, to which the Delesseriaceæ examined by Nieuburg are closely allied, showed direct development. Among Ceramiaceæ, the simpler forms (*Callithamnium*) show alternate branching, and the complicated forms (*Antithamnium*) show whorled and opposite branching. In *Cronania* the lateral branches are shortened; in *Ceramium* they do not grow out at all. *Griffithsia* also shows direct development. The Rhodomeleæ join on to the Dasyæ. *Dasya* remains for a long time monosiphonous. *Ricardia Montagnëi* develops in a similar manner. Not till later is a central axis developed. The Bonnemaisonniaceæ, examined by Nägeli, in which direct development is combined with the formation of an attachment-disk, lead up to the second great group in the developmental history of Florideæ, the attachment-disk type. The more simple forms of this group (*Halymenia* etc.), form the disk irregularly, while in the higher forms it arises from regular division of the spore. Further, the developmental stages of the upright shoot are worthy of attention. *Dudresnaya* forms closely packed upright filaments, in other genera the number of the entwined filaments is limited. In *Rhodophyllis bifida*, among others, an apical cell is formed later on, by which alone the upright shoot arises. Both types of upright organs are represented in one and the same family. The author considers that further research is necessary before drawing up a comparative developmental history of the Florideæ, in order to decide which characters are important and which unimportant, which are primary characters of organization and which are secondary adaptive characters.

Fossil Corallinaceæ †—C. Samsonoff describes two new species of fossil algæ preserved in the Geological Museum at Florence. The first is *Goniolithon Martellii*, and represents a genus which has hitherto never been recorded in a fossil state. It was collected in Middle Miocene

* Zeitschr. Bot., vi. (1914) pp. 209–78 (18 figs.). See also Bot. Centralbl. cxxviii. (1914)pp. 125–6.

† Atti R. Accad. Lincei., xxiii. (1914) pp. 238–43.

strata at Rakovicza in Albania. The second species is *Dermatolithon Lorisatoi*, and comes also from Miocene strata at Isili in Sardinia. The structure of both is described in detail.

Marine Algæ of Japan.*—S. Narita publishes a list of twenty-one marine algæ of Japan with diagnoses descriptive of the structure of a few new species and varieties. He adds a key to the Japanese species of *Chondrus*.

Edible Japanese Seaweed.†—A. D. Cotton describes an edible Japanese marine alga which is known in Japan as Tosaka-nori. As the result of investigations by himself and Dr. Yendo, he draws up a description of it under the name of *Eucheuma papulosa* Cotton and Yendo, and shows that it is identical with *Meristotheca papulosa* J. Ag. and *Callymenia papulosa* Montagne. The external appearance is extremely variable. The author gives the history of the plant, and records the confusion which has arisen with regard to its identity. The present description of its form and structure will prevent such confusion in the future.

Vegetation of Sargasso Sea.‡—W. G. Farlow discusses the vegetation of the Sargasso Sea and the various theories concerning it. As an instance showing how far specimens can be transported by currents without perceptible injury, he describes an interesting case of a mixture of Gulf-weed with a species of *Cystoseira*, collected by Prof. F. H. Storer on a voyage from the Cape of Good Hope to New York. The *Cystoseira* was entangled in the *Sargassum*, and the species proved difficult to determine even to Sauvageau himself. In any case, the *Cystoseira* must have come from the south-eastern shore of Europe or from northern Africa (including the Atlantic Islands) where the genus abounds. The author gives as his opinion that we are not as yet warranted in assuming that the floating Gulf-weed could not have been derived originally from some fixed fruiting form. We do not know at present from what species it might have been derived, but until the distribution of the Sargassa on the eastern coast of America and the West Indies is better known, and their characteristics and variations have been more thoroughly studied, the question of the origin of the Gulf-weed seems to him to be still open.

Fungi.

(By A. Lorrain Smith, F.L.S.)

Hypocrella and Aschersonia.§—T. Petch publishes preliminary notes on these two genera, both pyrenomycetous fungi parasitic on insects. He has as far as possible secured the types of all known forms, and he now gives the list of species with their synonymy. The

* Journ. Bot., lii. (1914) pp. 324–27.
† Kew Bulletin, 1914, pp. 219–22.
‡ Proc. Amer. Philos. Soc. Philadelphia, liii. (1914) pp. 257–62.
§ Ann. Roy. Bot. Gard. Peradeniya, v. (1914) pp. 521–37.

fungi are parasitic on scale insects, not on the tree on which the insects live, and they are very common in Ceylon. "The species are not confined to one insect, a species parasitic on one *Lecanium* may attack any Lecaniid—and any Lecaniid can be parasitized by fungus of the Lecaniicolous group. Consequently, a collection from one plant, usually all on the same scale insect, may include several species of *Aschersonia* or *Hypocrella*." The author goes on to state that several species of the fungus may be collected from the insects on one leaf. They all are brightly coloured at first, but blacken with age.

Study of Ascochyta on some Leguminous Plants.*—R. E. Stone, by experiment and observation, has followed the life-history of an *Ascochyta* on *Lathyrus sativus*. The pycnidial fungus was followed later by the perfect fruiting form, which has been named *Mycosphærella ontarioensis*. Usually the ascospore stage does not develop until the spring following the appearance of the pycnidial stage, but in the case of the present fungus, and also of an allied species on pea or vetch, the second or perfect form of the fungus appeared in July or August of the same season. The account of the cultures and inoculations is given in full detail.

Longevity of Spores.†—F. D. Heald and Studhalter have tested the length of time that spores of *Endothia parasitica* remain viable under artificial conditions.

Pycindiospores suspended in water at various temperatures showed a gradual reduction in the number that retained vitality, one-third only being viable at the end of forty-nine days.

These spores issue from the pycnidium in gelatinous masses or "spore-horns," and in that condition they retain vitality longer than when separated by water and then allowed to dry. The drying process itself was fatal to a number varying from 66 to 78 p.c. All of them were dead in two weeks.

Similarly, ascospores live a shorter time when separated in water and then dried. None so treated remained viable more than thirty-five days, and a large percentage were killed by the process; but both pycnidiospores and ascospores survived longer when dried on bark than on glass.

Abortive Sporophores of Wood-Destroying Fungi.‡—J. R. Weir has made a series of observations on the appearance of these abortive structures in *Fomes*, *Trametes*, etc. He found that the abortive fruiting structures of *Fomes igniarius* emerged from deep open wounds. Fertile normal sporophores more often appear directly through the bark or on wounds in which the vegetative mycelium is protected from external influences. "The collection of water in the deep open wounds, freezing and thawing, etc., has a tendency to maintain the mycelium at the

* Phytopathology, v. (1915) pp. 4–10 (figs.).
† Phytopathology, v. (1915) pp. 35–44 (1 pl.).
‡ Phytopathology, v. (1915) pp. 48–50.

point of exit in a vegetative condition; this and the probable oxidation of certain chemical substances within the wound due to exposure are probable causes for the formation of the peculiar abnormalities."

Rhizoctonia.*—F. L. Drayton has examined potato-stems showing dark-brown lesions similar to injuries caused by *Rhizoctonia*. He found on sectioning the stems that mycelium was present, and that it had invaded the cortex, vascular bundles and pith, forming sclerotial masses in the cortical cells. Drayton concludes that the injury is entirely caused by *Rhizoctonia*.

Carl Hartley and S. C. Bruner † describe the damping-off of pine-seedlings due to *Rhizoctonia*. It appears before the seedlings come up, and thus over fairly large areas no pines are developed. It attacks also seedlings too old to be killed by *Pythium debaryanum* or *Fusarium moniliforme*. It was found that the ground where it occurred had been previously occupied by *Ambrosia psilostachya* and other weeds, and that the *Ambrosia* plants had been attacked by the fungus.

Italian Fungus Flora.‡—The first volume of Hymeniales prepared by P. A. Saccardo has just been issued as part of the new Flora Italica Cryptogamia. The author gives a review of the system followed by him in selecting plates for reference, the nomenclature adopted, etc. In the introduction he describes the general structure of the thallus and the reproductive organs. He gives also the division into groups according to spore colour. The present volume deals with the Leucosporæ and the Rhodosporæ. He reckons that 13,992 species of Hymenomycetes are recorded up to the present time. An estimation of their food value is appended with a list of edible species in all the fungus groups. The poisonons species are also described.

In the main part of the volume full diagnoses are given in Latin, with synonomy, habitat, and distribution. Synoptic keys of families, genera and species are also furnished.

Scotch Microfungi.§—D. A. Boyd gives additional records of microfungi for the Clyde area. Several species are new, others new only for the district. Many of the species are parasitic. Interesting biological notes are appended.

Malcolm Wilson ‖ records two species of Uredineæ from the Royal Botanic Garden, Edinburgh. *Puccinia Prostii* was found attacking a bed of *Tulipa sylvestris* and doing considerable damage. *Uromyces Scillarum* formed characteristic yellow spots on leaves of *Muscari polyanthum*, a new host-species. Full descriptions of these species are given.

The same writer with R. C. Davie ¶ record the occurrence of

* Phytopathologist, v. (1915) pp. 59–63 (1 pl. and 1 fig.).

† Phytopathologist, v. (1915) pp. 73–4.

‡ Flora Italica Cryptogamia. Part I. Fungi, Hymeniales. Fasc. No. 14. Gennaio: 1915, 576 pp. (6 pls. and figs.).

§ Glasgow Naturalist, vi. (1914) pp. 75–8.

‖ Notes Roy. Bot. Gard. Edin., viii. (1914) pp. 219–21.

¶ Notes Roy. Bot. Gard. Edin., viii. (1914) pp. 227–8 (7 figs.).

Ustilago Vaillantii on the flowers of *Chionodoxa Luciliæ*, also in the Botanic Garden, Edinburgh. The fungus was confined to the anthers of the host-plant. The spores were germinated in water and in plum-decoction.

Washington Fungi.*—J. G. Hall describes and figures two new fungi from Pullman, Washington. The first, a species of *Neottiospora*, grew on dead or dying leaves of Yucca; the second, a Hyphomycete with peculiar boat-shaped or naviculate spores, grew on dead *Juncus* stems and was named *Tureenia juncoidea* g. et sp. n. Hall also describes a fungus that was causing canker on apple-trees in British Columbia, more especially on trees growing in low, poorly drained clay lands along the valley roads. In the cankers, at a later stage, the ascomycetous form was found, a species of *Otthia*. Cultures were made of the different spores.

Fungi of Padua.†—L. Gaia continues and completes his review of the fungi of Padua. The present contribution deals entirely with micro-fungi belonging to various classes, Ascomycetes, Fungi Imperfecti, etc. He also adds a list of Mycetozoa. In each case he gives the reference to Saccardo's Sylloge with the habitat and the record of Exsiccati of any Paduan specimens. At the end he lists the workers and the number of forms discovered or collected by each in the different groups. There is also a full index of all the genera. A diagram shows the gradual increase of knowledge of fungi from the year 1718 with two recorded species to 1912 with 1596.

New Marine Fungi on Pelvetia.‡—G. K. Sutherland has discovered several species of microfungi on *Pelvetia* collected on various parts of the British coasts. The alga forms a belt of vegetation "near the upper reaches of the tidal, and along those outer rocks which project into comparatively shallow water at high tide." They are submerged during high tides for a few hours every day. He finds that *Pelvetia* possesses a rich fungus flora, and in the case of one symbiotic species suggests, from observations made, that this special *Pelvetia* may be a lichen. The fungus species in question is *Mycosphærella Pelvetiæ*. The mycelium permeates the *Pelvetia* in all directions without doing visible harm, it finally penetrates the receptacles and forms its perithecia in the outer rind of the receptacles just as the reproductive bodies are being formed in the conceptacles. They rarely appear on the main vegetative body of the host. The spores escape at the same time as the oospores and germinate in contact with them.

The other three species, also new to science, are parasitic on the thallus. One of them, *Pleospora Pelvetiæ* destroys the thallus and thus becomes saprophytic.

Temperature Relations of Fungi.§—Adeline Ames has been testing the thermal germination and death points of a series of fungi. *Monilia*

* Phytopathology (1915) pp. 55–8 (2 pls.).
† Atti Accad. Sci. Ven. Trent. Istr., xii. (1914) pp. 7–79.
‡ New Phytologist, xiv. (1915) pp. 33–42 (4 figs.).
§ Phytopathology, v. (1915) pp. 11–19.

and *Penicillium* were able to germinate at 0° C. but growth was very slow. Other fungi tested: *Thielariopsis paradox*, *Rhizopus nigricans*, *Glomerella rufomaculans* and *Cephalothecium roseum* did not develop under 5 C. Except *Rhizopus*, none of them germinated above 36 C. The thermal death point of *Rhizopus* was found to be 60° C., of *Penicillium* 58° C. The practical results were the determining of the temperature necessary to prevent rotting due to these fungi. The author describes the methods employed by her in the various tests.

Fermentative Agents.*—A. C. Reavenall read a paper before the Institute of Brewing dealing with the question of the yeast supply, many tons of which are required daily in the making of bread. Yeast is always produced in great quantities at the breweries, and one way of utilizing it has been to dry it and use it as a cattle food. The writer describes the many methods of cultivating yeasts, the materials on which it may be grown with advantage, etc. He comments on the danger of spoiling the yeast by the presence of lactic and butyric acid organisms, and states that the growth of these can be inhibited by the previous introduction of lactic acid into the fermenting tun. The importation of yeast has been very large, but in recent years the output in this country has very greatly increased.

Enzymes of Aspergillus Oryzæ.†—This species of Aspergillus is employed in the preparation of *Saké*, and cultivated on rice yields *Koji*. The author (J. Tabramine) of a paper on the subject has grown it on wheat bran and calls the product *Taka-koji*, designed as a substitute for malt in various fermentation industries. He describes the method of manufacture.

Notes on Chestnut Fungus.‡—Caroline Rumbold has proved that the chestnut fungus attacks the fruit, and the disease may be spread to other areas by the nuts sold from infected regions. Nuts were collected and kept in moist conditions, when the characteristic yellow mycelium very quickly appeared.

Roy G. Pierce § reports that specimens of the disease have been gathered at two different localities in Nebraska. In one case, the disease was found to have girdled the main stem of a young tree, one of 600 which had been imported from Pennsylvania in the autumn of 1913. Chestnut trees are not indigenous in Nebraska, but they are beginning to be cultivated for the sake of the nuts.

Diseases of Sweet Potato.‖—L. L. Harter has investigated the extent to which sweet potato is affected by several well-known diseases. Stem rot, which is caused by *Fusarium hyperoxysporum* and *F. batatatis*,

* Journ. Inst. Brewing, xxi. (1915) pp. 97–110.

† Chemical News, cx. (1914) pp. 215–18. See also Journ. Inst. Brewing, xxi. (1915) pp. 117–19.

‡ Phytopathology, v. (1915) pp. 64–5.

§ Phytopathology, v. (1915) p. 74.

‖ Phytopathology, v. (1915) pp. 124–6.

was found in many districts. In Iowa 50 to 60 p.c. of the plants were infected, and occasionally a whole crop is destroyed. In other districts the disease was equally destructive. The varieties of sweet potato that are immune were noted.

Black rot is caused by *Sphaeronema fimbriatum*. It has a wide distribution, and in some localities is more serious than the stem rot.

Foot rot has also spread to new localities, and causes much damage. It is a comparatively new disease caused by *Plenodomus destruens*. At Sikeston, Missouri, individual plants were found in which the organism had grown down from the stem into the roots, forming fruiting bodies and partially decaying the tissue. A pure culture of *Plenodomus* was obtained from the decayed tissue within the potato.

Silver-leaf Disease.*—J. M. Hector has carried out an investigation on this disease, which is very prevalent in Berkshire, Hampshire and Middlesex. In the latter county 10 p.c. of the plum trees were attacked. The disease was also observed on greengage, damson, peach, nectarine, gooseberry, red currant, cherry, cherry-laurel, lilac and elder.

There is every reason to believe that the disease is usually spread by air-borne spores, and grafted trees are frequently attacked through the wood exposed by the grafting process.

Silver-leaf is a wound parasite. All dead wood should be removed and burned before the fructifications of the fungus causing the disease have time to develop.

Treatment of Potato Wart Disease.†—Experiments on badly diseased land have been made at Bardon Hill, near Leicester, by treating the soil with various substances. Watering with a solution of commercial formaldehyde was ineffective; the only potato not attacked being a well-known resistant type.

Other experiments in Lancashire with formaldehyde, mercuric chloride and sulphate of potash also failed to achieve satisfactory results. Mercuric chloride seemed to have increased the amount of disease. Formaldehyde made no difference.

Near Sutton Coldfield land was treated with superphosphate, and with superphosphate and soot in equal proportions, with copper sulphate and with kainit; still another plot was treated with salt. The test was not absolutely satisfactory owing to unfavourable weather conditions, but on the whole the results showed that in no case was there freedom from disease. The crop was very poor where salt was used.

* Univ. Coll. Reading, Faculty of Agric. and Hort., Bulls. Nos. 23-4. See also Journ. Board Agric., xxi. (1915) p. 1141.

† Journ. Board Agric., xxi. (1915) pp. 1126-8.

Lichens.

(By A. Lorrain Smith, F.L.S.)

American Lichenology.*—H. E. Hasse supplies descriptions and notes of new species and new records of various lichens in Southern California. He has found *Lecanora lacustris* on rocks which are only inundated during the brief rainy season of that country. Two are new species of *Rinodina* determined by A. Zahlbruckner.

Lincoln W. Riddle † gives the description of an American species of *Cetraria* determined by Tuckerman as *C. pallidula*, but till now unpublished. It is allied to *C. platyphylla* and to *C. juniperina*: from the latter it differs in the white medulla and the globose spores. Riddle suggests that according to Zahlbruckner's classification in the "Pflanzenfamilien" of Engler and Prantl it would be classified under *Nephromopsis*, though the reason for that is not given.

H. E. Hasse ‡ has published recently a new lichen, *Blastenia Herrei*, which he now recognizes to be identical with *Lecanora* (*Callopisma*) *atrosanguinea* Merrill. The species is abundant in Vancouver, the type locality. Either generic name is correct according to the classification adopted.

Schizophyta.

Schizomycetes.

Bacillus Isolated from a Case of Sprue.§—A. Distaso, from examination of the stools of a patient suffering from Sprue, has isolated an organism on Drigalski's medium, which he considers to be the causal organism of the disease. The bacillus in question belongs to the Friedlander and *Bacillus lactis ærogenes* group of bacteria. The organism produces acid and gas in glucose, lactose, raffinose, mannitol, and levulose, but has no action on sacchrose, salicin and dulcitol. It does not possess motility, and produces acid and gas in neutral red agar, while indol appears in a tryptophane medium. An autogenous vaccine produced a marked amelioration of symptoms, leading to complete recovery of the patient. Distaso proposes to name the new bacillus the *B. spruæ*.

Variations in the Antigen of the Plague Bacillus.‖—S. Rowland has demonstrated that the living avirulent cultures used by Strong in the Philippines for human inoculation only possess a slight protective value for guinea-pigs and laboratory rats, when tested against a test lethal dose of 3,000,000 virulent plague organisms from a passed culture (Laboratory strain) that killed 90 p.c. of normal rats. Of 20 guinea-pigs protected with a dose of 10,000 of Strong's organisms, 13 died of plague,

* Bryologist, xviii. (1915) pp. 22–3.
† Bryologist, xviii. (1915) pp. 27–8.
‡ Bryologist, xviii. (1915) p. 29.
§ Bull. Soc. Patholog. Exot. (1914) vii. pp. 268–70.
‖ Journ. Hygiene, Plague Suppl. iv. (1915) pp. 756–8 and 759.

a survival percentage of 35. When, however, the avirulent organisms were grown in a medium containing serum broth, a high degree of protection (73 p.c.) was afforded against the same test dose, even although the protecting dose was reduced to $\frac{1}{50}$ of the original dose.

When rats vaccinated against these organisms of enhanced virulence were tested against a culture of moderate virulence, which was obtained from one of Castellani's Ceylon cases, only 59 p.c. survived the test inoculation. The degree of immunity conferred was not striking, as 50 p.c. of unprotected controls survived inoculation with the same test dose of organisms. Thus the protection afforded by the Strong antigen against the Castellani strain was not nearly so good as that afforded against the Laboratory strain, notwithstanding the fact that the latter was the more virulent. Furthermore, of 49 rats vaccinated with the Strong antigen, 36 p.c. survived the test inoculation with the Laboratory strain, while of 47 rats vaccinated with the Laboratory strain antigen and tested with the same strain, no less than 60 p.c. survived. It is concluded that the two antigens are not identical, and that cross-immunization is not complete. It is suggested that such differences in antigenic properties may to some extent account for the disappointing results obtained in Java and elsewhere with Haffkines' prophylactic fluid.

Development of Bacillus pestis in Bugs.*—A. W. Bacot has confirmed the observations of Verbitsky and others as to the possibility of the bug (*Cimex lectularius*) becoming a carrier of plague, under experimental conditions. Bugs were allowed to suck the blood of infected mice that were in the comatose condition that precedes death from plague, and, if they managed to survive the infecting meal, they were found to be capable of carrying *Bacillus pestis*, and of reinfecting mice for a period of time up to forty-eight days. A certain proportion of the bugs, however, and probably all newly hatched ones, do not survive the ingestion of the bacilli, and die in a paralyzed condition.

The structural character of the ingested blood is preserved unaltered for many days in the crop of the insect, and the development of *B. pestis* is slower, and the resulting growth looser, than is met with in the case of flea infection. This, taken in connexion with the fact that there is not any distinct valve between the pump and the crop, precludes the idea of mechanical blockage, such as has been met with by Bacot and Martin (see this Journal, 1914, p. 295) in fleas in which the proventriculus becomes blocked with plague culture.

One of the difficulties encountered in Bacot's experimental work was due to the eating of the bugs by the mice in the cages. This undesirable state of affairs was overcome by placing pieces of wood, in which a number of saw cuts had been made, in the cages. The bugs were thus afforded cover from the attacks of their rodent hosts.

Autogenous Living Vaccine in the Treatment of Enteric Fever.†—Major E. A. Bourke, Lieut. I. D. Evans, and Lieut. S. Rowland report

* Journ. Hygiene, Plague Suppl. iv. (1915) pp. 777–92 (2 pls.).
† Journ. R. Med. Corps, xxiv. (1915) pp. 5–12.

satisfactory results from the employment of autogenous living vaccines in cases of enteric. The vaccines were prepared from broth cultures.

Five c.cm. of blood were withdrawn from the arm of the patient and immediately transferred to 1 p.c. sodium taurocholate solution. From this a broth culture was prepared, and the purity and identity of the growth verified by agglutination and sugar fermentation tests. The broth culture was reinoculated into fresh broth, and itself constituted the vaccine. The average number of bacilli given as a dose ranged from about 60,000,000 to 300,000,000.

The local reaction from inoculation was very slight, and was followed by a rise of temperature, which was succeeded by a marked fall within twenty-four hours. The authors have no doubt but that the treatment had a beneficial effect, and tended to cut short the duration of the disease. In one case, which promised to be a severe one, the patient was convalescent on the thirteenth day after the first inoculation.

Typhoid and Paratyphoid Infection in Relation to Antityphoid Inoculation.*—G. Dreyer, E. W. Ainley Walker, and A. G. Gibson point out that unless all cases of "enteric" are properly differentiated into typhoid and paratyphoid fever infection, the statistics regarding the value of antityphoid vaccination among our forces in the present war will be most seriously vitiated. The agglutination test is by far the quickest method of diagnosis, the serum of the patient being subjected to routine-testing against the three micro-organisms, *Bacillus typhosus*, *B. paratyphosus* A., and *B. paratyphosus* B. Individuals that have been inoculated with an antityphoid vaccine within a period of some months, or even years, will give a high agglutination titre against *B. typhosus*, but if the test be repeated at short intervals it will be found that there is no appreciable alteration in the reaction. One example will suffice. A patient exhibited a high agglutination titre (1 in 1500) against *B. typhosus*, having been inoculated in September, 1915, against the disease. There was no variation in the titre for six successive days, but during the same period paratyphoid B. agglutination rose rapidly from 1 in 300 to 1 in 700. Agglutination with paratyphoid A. was nil. The case was clearly one of paratyphoid B. infection at an early stage.

Typhoid vaccination does not give the slightest protection against paratyphoid infection, and it is of the utmost importance that our troops should be protected against paratyphoid infection as well as against the *B. typhosus*. The recent work of Kabeshima affords full evidence, both from animal experiments and from extended observations carried out on the personnel of the Imperial Japanese Navy, of the great protective value as well as the innocuous character of the paratyphoid vaccination. Kabeshima used a mixed vaccine containing equal numbers of typhoid, paratyphoid A. and paratyphoid B. bacilli. About 12,000 men have been inoculated with the mixed vaccine, the following table showing the results recorded in five Naval hospitals in Japan during the period

* Lancet (1915) i. 324-8.

1909–1911, after the introduction of inoculation with the mixed vaccine :—

Disease	Total Number of Cases	Cases in Inoculated Subjects		Cases in Non-inoculated Subjects	
		Sick	Dead	Sick	Dead
Typhoid	367	68	5	299	40
Paratyphoid A. .. .	289	71	2	218	5
Paratyphoid B.	447	0	0	447	0

Sperm Oil Turbercle Bacilli.*—A. H. Miller has followed up a suggestion with regard to the employment of wax media for the cultivation of the tubercle bacillus. Solid waxes were first added to agar—e.g. beeswax, gondang, pisang, carnuba, and Chinese wax, neutral soaps being included so as to assist mixing.

No growth occurred on these media, but it was found that the employment of a liquid wax, e.g. sperm oil, gave a satisfactory growth. The bacilli must be actively growing, old cultures not showing any development on oil media. A moist growth appears in about twelve days, but the bacilli do not appear to be different from those obtained from other sources. After a further period of about three weeks curious morphological differences become manifest, the organism growing on the surface of 5 p.c. crude oil and 5 p.c. glycerin as a thick uniform greasy pellicle. Microscopically it alters considerably in shape and form, beginning to branch and exhibiting "granules" or "spore-bodies" and irregularities in staining. A two months' old culture was passed through a guinea-pig, the animal dying twenty-two days later, with the liver, spleen, omentum and glands nearly solid with tubercles. Many of the bacilli from these lesions exhibited the "granule" or "spore-body" sharply defined and intensely stained, and having attached to it the bacillary portion of the organism. It is also to be noted that there were forms present in which two "spore-bodies" were fused together with their bacillary portions issuing out at opposite poles. With the above characteristics it is difficult to regard these bodies as in any way degenerative.

Bacterium of Gummy Beet-roots.†—G. Arnaud describes a condition which has been recently met with in the French sugar-beet, in which the cellular elements become destroyed and the intercellular spaces become filled with a gummy material. This condition is invariably associated with the presence of a bacillus, which resembles morphologically the *Bacterium mori* of Murier.

In beet-root juice media at high temperatures (38° to 40° C.) the bacterium either develops as long thin filaments without segmentation, or as elements undergoing process of segmentation, so as to suggest the

* Lancet, 1915, i. pp. 704–5 (2 figs.).
† Comptes Rendus, clx. (1915) pp. 350–2.

appearance of a rosary, resembling both as to form and dimensions the granules of *Leuconostoc mesenteroides*.

The infection cannot be transferred to healthy beets, even when they are cut in half and applied to a gummy beet. It is probable that diverse agents that reduce the vitality of the cells are responsible for the development of the gum bacterium. The exceptionally cold winter in France, and the great difficulties of agricultural transport owing to the European war, may well account for the lowering of the vitality of the beets which were attacked by the bacterium.

Disappearance of the Spores of Bacillus perfringens from the Fæces of Immunized Monkeys.*—S. Marbais has shown that the subcutaneous injection of abundant cultures of the *Bacillus perfringens* into monkeys (*Rhesus*, *Sinicus* and *Cynomolgus*) is not followed by the production of gas gangrene or gas abscess, the local reaction provoked by the inoculation rapidly disappearing. The inoculation of 100,000,000 living organisms per kilo. of monkey is followed by irritation of the large intestine and by tumefaction of the anal muscle, accompanied by blood-stained and grairy diarrhœa.

Monkeys so inoculated acquire an active immunity which is characterized by the disappearance of the spores of the bacillus, and in general all spores, from the fæces of the animal.

Researches in Gas Gangrene.†—The causal organism or organisms of gas gangrene, which produced such terrible ravages among the wounded at the battle of the Marne, may be identified with the group of bacteria that contains *Bacillus perfringens* (Veillon) (*B. capsulatus aerogenes* of Welch).

M. Weinberg has prepared an "anti-perfringens" ("anti-P.") serum, by means of the intravenous injection in horses, at first of dead cultures, and then of living cultures of *B. perfringens*. After three months' immunization the serum was tried on guinea-pigs with encouraging results—guinea-pigs given 1 c.cm. of the serum intravenously readily surviving a subsequent lethal dose of the organism, and not giving any local reaction at the seat of inoculation. Moreover the serum possessed a curative value—2 c.cm. of serum intravenously and 3 to 5 c.cm. in the neighbourhood of the lesion, saving the life of one out of five guinea-pigs that were *in articulo mortis* from perfringens infection.

The serum has been tried in one case of gas gangrene at the Saint Michel Hospital with the most satisfactory results. The wounded soldier received an intravenous injection of 22 c.cm. of the anti-P. serum, and a marked improvement in his condition, leading to eventual recovery, rapidly manifested itself.

New Pathogenic Yeast (Saccharomyces Lamonnieri sp. n.).‡—A. Sartory and Ph. Lasseur have isolated an entirely new species of

* C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 50–2.
† Comptes Rendus, clx. (1915) pp. 325–8.
‡ C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 48–9.

Saccharomyces from the expectorations of a patient at the Malgrange Hospital at Nancy. The new yeast consists of rounded elements enclosed in a thick capsule 3·1–3·5 μ in diameter, looking at first sight like an enormous diplococcus full of refractile granules, which stain strongly with basic aniline dyes. The yeast grows well on all the principal media used in mycology, the optimum growth on carrot being between 25° to 30° C.

On microscopical examination, the young scum, which appears in pepto-glycerin broth, was found to consist of elongated elements which had almost entirely lost their capsules. The sediment, on the contrary, contained spherical cells with very obvious capsules. The formation of ascospores has been obtained on plaster blocks and on blotting-paper impregnated with a solution of lactose. Each ascus encloses four spherical spores measuring 2·5–3·0 μ in diameter, disposed in tetrads.

Cultural characters. Thick creamy white growth on carrot. Growth on potato (plain, acid, or glycerinated) or Jerusalem artickoke is slower: the creamy-white colonies are small but very obvious. The growth on gelatin is scanty and superficial; liquefaction of the medium takes place on the eighth day. The growth on agar is at first white, but rapidly changes to a chocolate-brown colour; the same remarks apply to growth on ascitic agar and inspissated horse serum respectively. The new *Saccharomyces* secretes invertase, produces alcoholic fermentation, coagulates milk, and precipitates casein without peptonization; it has no action on starch or inulin, and does not turn neutral-red solution.

Saccharomyces Lemonnieri is very virulent for the rabbit and guinea-pig, producing a voluminous tumour at the seat of inoculation.

New Pyogenic Bacillus.*—A. Sartory and P. Lasseur make a preliminary statement in regard to a pyogenic organism which they have isolated from three cases of shell-wounds. The bacillus is from 5–7 μ long and about 0·5 μ broad. It is usually curved and swollen at one end. Involution forms are common in old cultures. It stains well with aniline dyes and also by Gram's method. It grows well on all media, the optimum being from 28° to 35° C. It liquefies gelatin. Broth becomes turbid. On agar the growth is moist, yellowish, becoming greyish with time. On potato a yellowish white overlay occurs. Milk is coagulated with formation of acid, and the casein is slightly peptonized. In neutral-red broth the medium turns orange-yellow with production of slight fluorescence. Injected into animals the bacillus gave rise to putrid abscesses.

Behaviour of Marine Bacteria to Salt.†—H. Coupin finds that marine bacteria enjoy considerable tolerance in regard to sodium chloride, since they are able to support the presence of 8 to 16 p.c. of sea-salt, while on the other hand they can do with as little as 0·3 p.c. of the same salt. Moreover, they adapt themselves proportionately better to low salinity than to a high degree of salinity.

* C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 68–9.
† Comptes Rendus, clx. (1915) pp. 443–5.

In a further communication * the author describes the morphogenic action of a high degree of salinity. The bacilli, instead of disarticulating, increase in length, become filamentous, and occasionally are transformed into *Spirilla*.

Citrate of Soda and Agglutination of Bacillus typhosus.† A. Sartory and P. Lasseur record the results of an investigation to ascertain if the presence of citrate of soda accelerates or retards the agglutination of *B. typhosus*. They find that citrate of soda alone has no agglutinating effect; that citrate of soda added to fresh serum has no marked agglutinating action; that when a serum has a feeble agglutinating power, citrate of soda seems slightly to mask the results by increasing a little the rate of agglutination.

Morphological Variation of Mycoderma vini.‡—R. Perotti concludes from numerous experiments that varying concentrations of glucose, diversity in the sources of carbon, different concentrations in the nitrogenous compounds, the acidity and the amount of alcohol in the nutritive media determine notable morphological variations in the cells of *Mycoderma vini*.

These variations affect the dimension and shape of the cells, which decrease or double in size. They may be elongate, bacilliform, round, cocciform, or may be rounded off at one end and elongated at the other.

* Comptes Rendus, clx. (1915) pp. 608–10.
† C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 36–8.
‡ Atti R. Accad. Lincei, xxiii. (1914) pp. 423–6.

MICROSCOPY.

A. Instruments, Accessories, etc.*

(1) Stands.

Swift and Son's "Improved Dick" Petrological Microscope (Khartum Model).†—The first Microscope of this type (fig. 30) was built to the specification of G. W. Grabham, Senior Geologist to the Sudan Government, Khartum. Possessing all the features of previous "Dicks," it provides also additional adjustments, and permits the use of further apparatus of the greatest practical utility to mineralogists. It is provided with a rack-and-pinion focusing substage with centering movements, which carries a triple nose-piece for the different condensers, an iris-diaphragm, and a rotating swing-out cell for stops. Any condenser with the R.M.S. standard screw can be used. The iris-diaphragm fitted below the condenser serves not only to regulate the illumination of the object, but also to cut down the cone of light in order to test the refractive indices of minerals and mounting media. The rotating swing-out cell carries stops for giving oblique and dark-ground illumination.

(3) Illuminating and other Apparatus.

Hutchinson's Universal Goniometer.‡—This instrument (fig. 31) is a goniometer of the suspended type. It is intended for the examination of small crystals, and by its aid all the usual crystallographic and optical determinations can be carried out. It is specially adapted for the following purposes:—(1) as an ordinary goniometer: (2) as an axial-angle apparatus; (3) as a Hohlrausch total reflectometer; (4) for determining refractive indices by the prism method.

A circle D, 5 in. in diameter, graduated to half degrees and reading by a vernier to minutes, is supported by a stout bracket S, at a height of 10 in. above a base plate P, 11 in. square. The circle is provided with a slow-motion attachment, and can be clamped by the screw E. A steel rod, which can be clamped at any convenient position by the screw F, passes through the centre of the circle and carries at its lower end the centering and adjusting head shown at G. A loose collar, which can be clamped to the rod by the screw R, gives the means of raising the adjusting head and of again lowering it to its former position.

A telescope A and a collimator C are securely clamped to the base-

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† J. Swift and Son's Catalogue, 1914, pp. 17–8.

‡ J. Swift and Son's Catalogue, 1914, pp. 28–9.

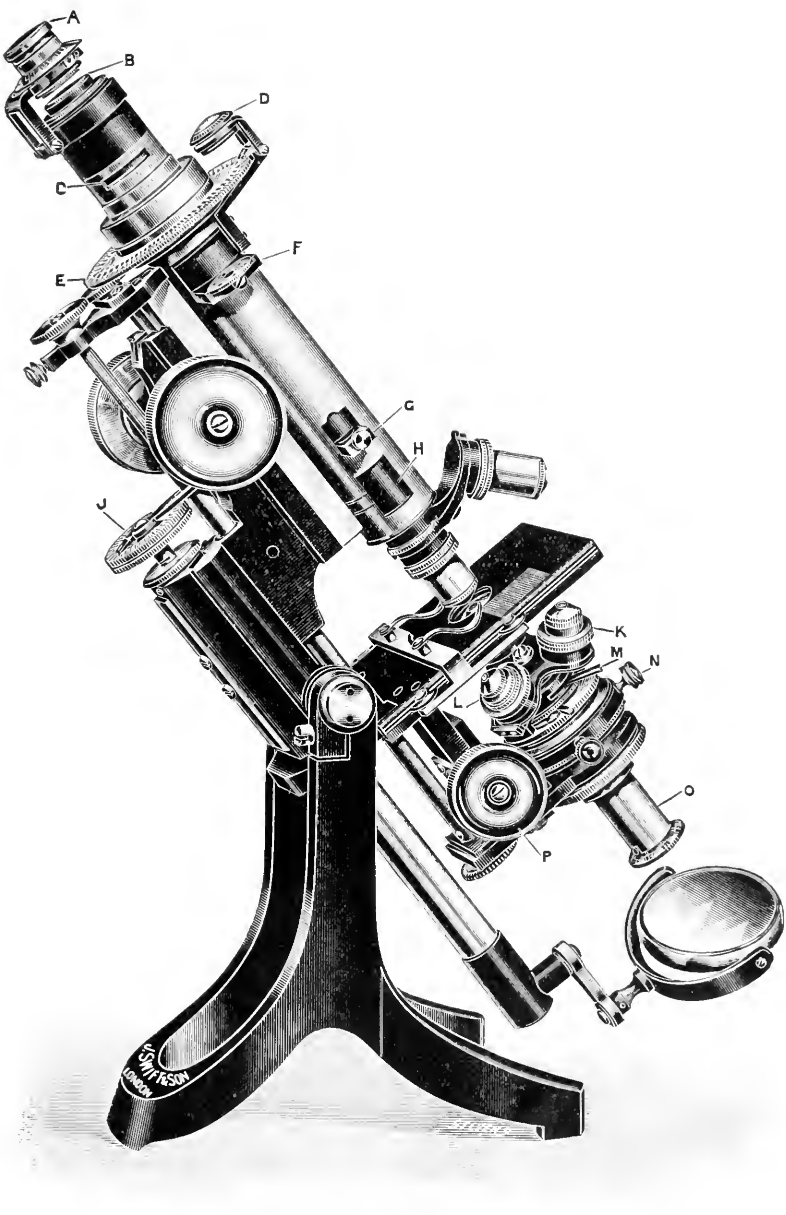


Fig. 30.

plate in the manner shown at K, a number of holes being provided for this purpose at convenient positions. The object-glasses of the telescope and collimator are $\frac{3}{4}$ in. in diameter and about 4 in. focal length. Their tubes are carried by collars provided with adjusting screws. An additional lens of $2\frac{1}{2}$-in. focus is hinged over the object-glass of the telescope to convert it into a Microscope of low power, with which the crystal can be directly examined. The telescope and collimator can be placed at any convenient angle to one another, and the Microscope B is

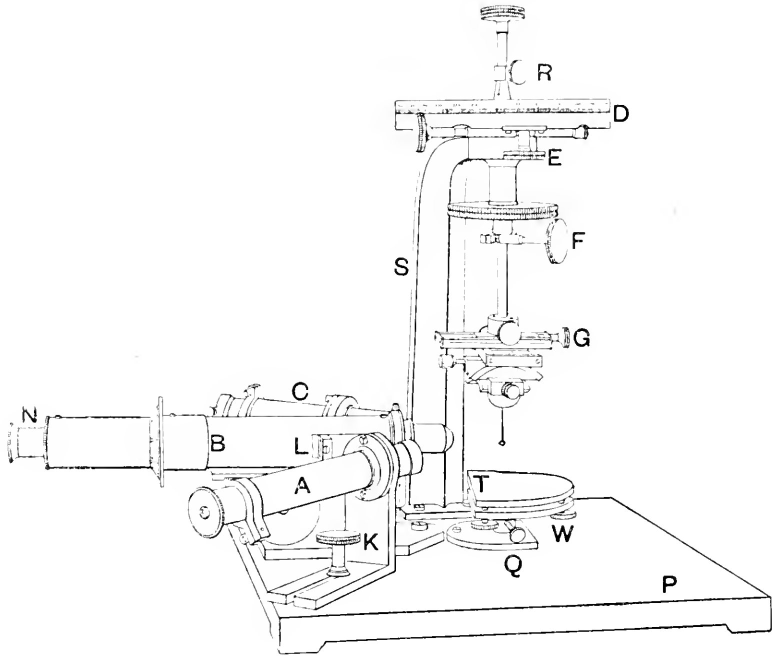


Fig. 31.

arranged so that its optic axis bisects the angle between them. The Microscope tube, which is 8 in. long, is moved by a rack-and-pinion coarse-adjustment. At the nose-piece end it carries the tube-fitting of a centering objective-changer, which enables different objectives to be rapidly slipped into position. At the other end of the Microscope a rotating analyzer N slips over the cross-webbed ocular; this latter and the prism-holder are slotted to admit of the insertion of a quartz wedge, mica plate, or other compensator. A Bertrand lens L slides in the body of the Microscope.

An adjustable table T, which can be levelled by the screw W, is carried by a steel rod, which can be clamped by the screw Q; a loose collar, clamped to the rod by a screw, enables the table to be rotated when supported at any convenient height. On this table can be placed

a tank when it is desired to observe the crystal immersed in a liquid. There are some other supplementary fittings.

When the instrument is being used as a total reflectometer, and fairly large crystal plates are available, the Microscope can, by means of a special objective and ocular, be converted into a telescope.

(4) Photomicrography.

Colour Screens.*—J. E. Barnard has used the following methods in the preparation of colour screens for photomicrographic use. Permanent screens may be made by staining either gelatin or collodion films. A $7\frac{1}{2}$ p.c. solution of gelatin in distilled water is melted down over a water-bath and then filtered through glass or cotton wool. The indicated dye is then added to the solution, and a suitable proportion of gelatin then poured on to the plate and allowed to dry in a perfectly horizontal position where dust is not likely to settle on it. Another, and perhaps more preferable, method is to immerse a gelatin plate in a solution of the dye until a sufficient depth of colour has been taken up by the film. The solution of aniline dyes used should be of a strength of 1 in 1000, with the exception of yellow dyes (e.g. acradine yellow, auramine, or tartrazine), which may be used as strong as 1 in 250. Enamel collodion may be used instead of gelatin, the dye being in this case dissolved in absolute alcohol and added to the collodion before the plate is coated. The best quality of enamel collodion must be used in order to insure a perfectly clear film.

The use of a fluid screen has the advantage of simplicity and the easy control of absorbing power. For use with such fluid filters a simple type of cell may be formed of a rubber band, from which a segment has been cut, fixed between two thin glass plates by a pair of spring clips, the depth of the cells being varied by the employment of bands of different thicknesses. The dyes used are kept in stock solution, and a fluid screen can be improvised at any time in a few moments.

The use of a mercury vapour lamp as a source of light is of particular advantage in dealing with objects that are faintly stained with methylene blue, and which often give only very faint images in photomicrographic work. By using a screen that transmits the yellow mercury vapour line, one can be perfectly sure that no blue is transmitted, and thus the utmost contrast is secured.

Directions are given for the preparation of the various fluid filters that have given good results in the lecturer's hands:—Gifford's screen (methyl or malachite green dissolved in warm glycerin), Zettnow's green filter (cupric nitrate and chromic acid dissolved in water), yellow screen (10 p.c. solution of acradine yellow in absolute alcohol; one part being added to four parts of enamel collodion), and blue screen (ammonio-sulphate of copper).

* Journ. Photomicrograph. Soc., 1915, iv. pp. 1–8.

(6) Miscellaneous.

An Amateur's Introduction to Crystallography.*—Under this title W. P. Beale has produced a very useful and serviceable treatise. He states that it is his intention to help other amateurs to find in the problems of Crystal Morphology occupation of practical interest in itself leading to the more fascinating study of the optical and other special properties of crystalline structures, and pointing to further fields of study in molecular physics, which he (the writer) can only see faintly and beyond his reach. At the same time the book does not shirk difficulties. It commences with the study of an actual specimen, and shows how the crystalline faces and edges can be connected with a system of axes and co-ordinates, and so gradually leads up to an explanation of the thirty-two systems. Methods of measurement and calculation, are introduced, and special difficulties are reserved for two appendices. The book is very clearly printed, and the illustrations are unusually well done.

B. Technique.†

(1) Collecting Objects, including Culture Processes.

Detection of Trypanosomes in Animals.‡—Mühlens draws attention to the following method devised by A. Lundie § for the investigation of trypanosomes. The suspected blood is allowed to run into a test-tube, which contains a solution of 5 c.cm. of sodium citrate in 5 c.cm. of sterile water, until the tube is three-quarters full. The contents are then mixed by rolling in the hands. After about half an hour it will be observed that a small quantity of clear fluid has separated out over the blood layer. If trypanosomes are present they will be found in this clear fluid layer. The author is of opinion that the development of trypanosomes may be followed by this method, and that by the addition of hydrochloric acid, the developmental cycle in the *Glossina* may be simulated.

Detection and Identification of Bacillus typhosus and B. paratyphosus.‖—G. Dreyer, E. W. Ainley Walker, and A. G. Gibson point out that, in view of the importance at the present time of retaining convalescent soldiers under observation and control until they cease to act as carriers, it is essential that the method used in making examinations should be one in which a negative finding represents as nearly as possible a true negative. The method of direct plating on so-called selective media has often proved to be misleading.

An extensive series of experiments was carried out with the media

* Longmans, Green and Co., London, 1915, 220 pp., many figs.

† This division contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Embedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including Slides, preservative fluids, etc.; (6) Miscellaneous.

‡ Centralbl. Bakt., Ref. lxii (1913), p. 522.

§ Journal of Tropical Medicine and Hygiene, xvii (1914), p. 22.

‖ Lancet, 1915, pp. 643–7.

of Drigalski and Conradi, MacConkey and Endo, and the outstanding conclusion derived from these researches was that all these media eliminate a very large proportion of typhoid (and even paratyphoid bacilli), and do not to any very notable degree inhibit the growth of *B. coli*. The following table shows the kind of results that were obtained :—

Medium	Number of Colonies on Plates Inoculated with *B. typhosus* 20 c.cm.			Number of Colonies on Plates Inoculated with *B. coli* 20 c.cm.		
	Experiments			Experiments		
	(1)	(2)	(3)	(1)	(2)	(3)
Ordinary agar	265	150	90	1100	550	86
Endo's medium	245	135	85	1000	500	60
MacConkey's medium ..	2	1	0	950	450	70
Drigalski-Conradi medium	2	0	0	1050	500	64

The good result here shown with Endo's medium was only obtained when the medium was very fresh. The colonies of *B. coli* on Endo's medium are well developed, of a deep red colour, and gradually acquire an intense metallic sheen, while those of *B. typhosus* are at first only faintly rosy in colour, and though they eventually become red they never acquire any metallic lustre.

It is suggested that this medium might well be used instead of MacConkey's medium in the technique of the brilliant green enhancement method of Browning, Gilmour and Mackie.

The authors have devised a technique for the rapid isolation of *B. typhosus* or *B. paratyphosus A.* or *B.* in twelve or twenty-four hours by means of a single plate. The method consists of the subjection of an ordinary agar plate, liberally spread with the bacterial emulsion, to a graduated exposure to the rays of an arc light, silver electrodes giving the best results.

The lamp consists of two small metal pillars bracketed on an insulating slate base. The pillars carry the horizontal arms upon which electrodes, water-cooled after the manner devised by Bang, are screwed. These arms can be approximated to each other by means of thumbscrews. They consist of an outer tube within which runs a smaller inner tube, serving as inflow for the cooling water, which returns by the outer tube. The arc is made by an electric current of 5 to 7 amperes, with a voltage of 30 to 35 volts. In exposing an inoculated plate, the lid is removed and the agar surface is directly exposed to the arc at a distance of about 6 cm. Upon the Perti dish is placed a sheet of blackened metal in which an oblong window has been cut. By means of another sheet of blackened metal, the window, at first fully opened, is gradually closed, the different exposures along the strip varying from 30 to 240 seconds. In making a plate, from 0·5 to 1 c.cm. of faeces are broken down in 2·5 c.cm. broth and allowed to stand for about two hours. Two or three drops are then taken from the upper part of the fluid and

spread on the surface of the plate to be subjected to the action of the electric arc.

Whereas with the selective media in present use, typhoid bacilli when mixed with large proportions of *B. coli* are only recovered with extreme uncertainty, by the new technique, in cases where the proportion of coli to typhosus was as 500 to 1, a few isolated colonies of the latter were recovered. On applying the method to the examination of the fæces of convalescents and suspected carriers, seven have already yielded positive results by this method at the first examination, though the ordinary methods failed to afford any evidence of the presence of *B. typhosus* or *B. paratyphosus*. In five of the cases *B. typhosus* was isolated, and in the remaining two, *B. paratyphosus B.* Although it would not be wise to make broad generalizations from the results of these few cases, it must be admitted that so far as they go they are very encouraging.

Some Simple Anaerobic Methods.*—P. P. Laidlaw has employed three new methods for the cultivation of anaerobic organisms, with the idea of simplifying the attainment of anaerobic conditions. The point which he has set out to obtain is the avoidance of costly and bulky apparatus, and to devise a technique for use in a travelling laboratory which might be of service to those working with anaerobic bacteria in the field, for those whose space is limited, and who cannot take a large equipment with them.

Method 1. *Porous Platinum.*—This method is the simplest, and is applicable to solid or liquid media, and for these reasons is probably the best.

Short pieces of platinum wire are fixed into glass holders at the blow-pipe, and the free ends are wrapped tightly round small pieces of gas carbon and secured by twisting round the main piece of wire. The carbons are then heated in the flame to expel the air, and are dipped, while still hot, into a strong solution of platinic chloride. After soaking they are removed and dried in the flame. They are then heated red hot and re-dipped, and the process repeated several times. On removal from the flame the reduced platinum on the surface of the carbon will absorb sufficient oxygen from the air to keep the mass at a dull red until all the carbon has been burned away.

The glass holder is cut short and pushed into the centre of a cork. With this and a Kipp's hydrogen apparatus the atmosphere above a medium can be rendered anaerobic in a few minutes. With solid media (e.g. a blood-agar slope) the tube is inoculated in the usual way, the plug removed, and the tube turned upside down. A sterile capillary tube is connected with the hydrogen apparatus, introduced with a cotton-wool plug from below, and a stream of hydrogen run into the test-tube. The capillary is removed and the sterilized platinum-armed cork is pushed home, the joint being secured with melted paraffin-wax. The platinum will glow dull red when introduced, and continue to do so until all residual oxygen has been used up in forming water. If insufficient hydrogen has been introduced, the platinum will become

* Brit. Med. Journ., 1915, i., pp. 497–8.

white-hot and an explosion will result. The hæmoglobin in the superficial layers of the medium becomes reduced as the oxygen is given up, and the surface is rendered suitable for anaerobic growth in a few minutes.

By this method the organisms of tetanus, botulismus, and malignant œdema grow with great freedom, and nearly the whole surface of the medium is covered with growth in forty-eight hours. Plating methods may be adapted by use of the Roux bottle, or similar contrivance, using larger pieces of platinum and plenty of hydrogen, as explosions in such bottles might be dangerous. When taking samples with a warm platinum loop several minutes should be allowed to elapse after opening the bottle, in order to avoid risk of explosion.

The method can be applied to broth. As the tube cannot be held upside-down, a very brisk stream of hydrogen is bubbled through the medium and the tube corked up as soon as possible after the capillary has been withdrawn. The method is rapid and simple in theory and practice, and is quite cheap, as the pieces of platinum can be used again and again. A tube or bottle can be inoculated, rendered anaerobic, and put in the incubator in a few minutes.

Method 2. Colloidal Platinum.—In this method, test-tubes which have been cut short are introduced upside-down into the lumen of somewhat larger tubes. These tubes are filled with broth to which a trace of methylene-blue has been added. The tubes are then plugged and sterilized; 2 c.cm. of platinum sol are added to each tube, the tube inoculated, and a stream of hydrogen passed through the upper layers of the medium by means of a fine capillary. The methylene-blue is gradually bleached, the colloidal platinum acting as a catalyst, and the hydrogen gradually destroying all the oxygen present in the medium. The capillary is then passed down to the bottom of the tube, and the inner tube filled with hydrogen. The capillary is then withdrawn, and the tube plugged and subsequently incubated. The hydrogen in the inner tube acts as a reducing agent which destroys oxygen from the surface of the medium. The method gives good results with the organisms of botulismus and malignant œdema, but with tetanus the growth is slow and poor.

Method 3. Colloidal Platinum and Sodium Formate.—An attempt to dispense with hydrogen was made by adding to broth excess of sodium formate and colloidal platinum, the idea being that the free oxygen would be used up in oxidizing the formate owing to the vigorous catalytic action of the colloidal platinum. In broth, however, some constituent interferes with the reaction. Bouillon made with Witte's pepton (Douglas) did not give good results, but broth made with a tryptic digest proved to be more suitable. To the latter medium was added a trace of methylene-blue, sodium formate up to 1 or 2 p.c., and, just before inoculating, 2 c.cm. of colloidal platinum, or platinum-black suspension. The tubes were plugged with cotton-wool, and the contained media thus given free access to the air. The tubes remained anaerobic for twenty-four or forty-eight hours. *B. Botulinus* grew extremely well and regularly, the bacillus or malignant œdema less regularly, while the *Bacillus tetani* either grew badly or not at all.

Although by Methods 2 and 3 the platinum used is not recovered, the weight of metal thrown away is extremely small and the cost is not great. The last two methods require further work to endeavour to get over the uncertainty and poor growth with the tetanus bacillus.

Studying the Mitotic Spindle in the Spermatocytes of Forficula auricularia.*—C. F. V. Meek preserved the material, obtained in July and August, in Flemming's strong chromo-aceto-osmic acid fluid. The testes remained in the fixative for twenty-four hours, and after washing in running water and passing through upgraded alcohol, were cleaned in xylol and embedded in paraffin. Sections were cut 8 μ thick with a Cambridge rocking microtome.

All sections were stained on the slide; the slides were placed for four to six hours in an aqueous solution of ferric alum, and were then stained for twelve to fifteen hours in Heidenhain's iron-hæmatoxylin. In certain cases they were first stained for ten minutes in eosin. The preparations were studied with an apochromatic oil-immersion objective of 2 mm. focus and N.A. 1·30 and compensating oculars. The light was obtained from an inverted incandescent gas-burner, and was passed through a Watson holoscopic oil-immersion substage condenser. The photo-micrographs were made with a Zeiss camera, the apochromatic objective mentioned above, and compensating ocular No. 4. The camera extension was 50 cm. in the case of photographs of individual cells, and 25 cm. in the case of photographs of cysts. The magnification was estimated with a stage micrometer graduated to read one-hundredth part of a millimetre.

(2) Preparing Objects.

Crystal-grinding Apparatus.†—This instrument (fig. 32) was designed by H. H. Thomas and W. C. Smith to facilitate the cutting and polishing of optically orientated parallel plates and prisms of mineral substances. It consists of a triangular metal plate B, traversed by three steel screws, one of which, S, carries a graduated head. The pitch of the graduated screw is such that one revolution imparts a tilt of half a degree to the axis of the instrument. This axis is occupied by a solid metal cylinder P, capable of vertical movement and of rotation within the graduated collar D. After rotation it may be clamped in any desired position by the screw C, but still retains its power to move vertically. The lower end of the cylinder is drilled to receive a series of chucks or crystal-holders which are bevelled off at angles different by 10° from each other, so that by the use of chucks and the graduated screw S a face at any desired angle from 0° to 90° may be cut and polished upon a crystal. For the cutting of parallel plates and other sections it is essential that the axis of the instrument should be first set accurately normal to the grinding surface; an optical method has been found most suitable for this purpose, and the usual levelling system has been dispensed with. A tube, carrying an optical flat F at its lower end and a vertical illuminator R at its upper end, is inserted down the

* Quart. Journ. Microscop. Sci. lxi. (1915), pp. 1–14 (2 pls.)
† J. Swift and Son's Catalogue (1914), pp. 26–7.

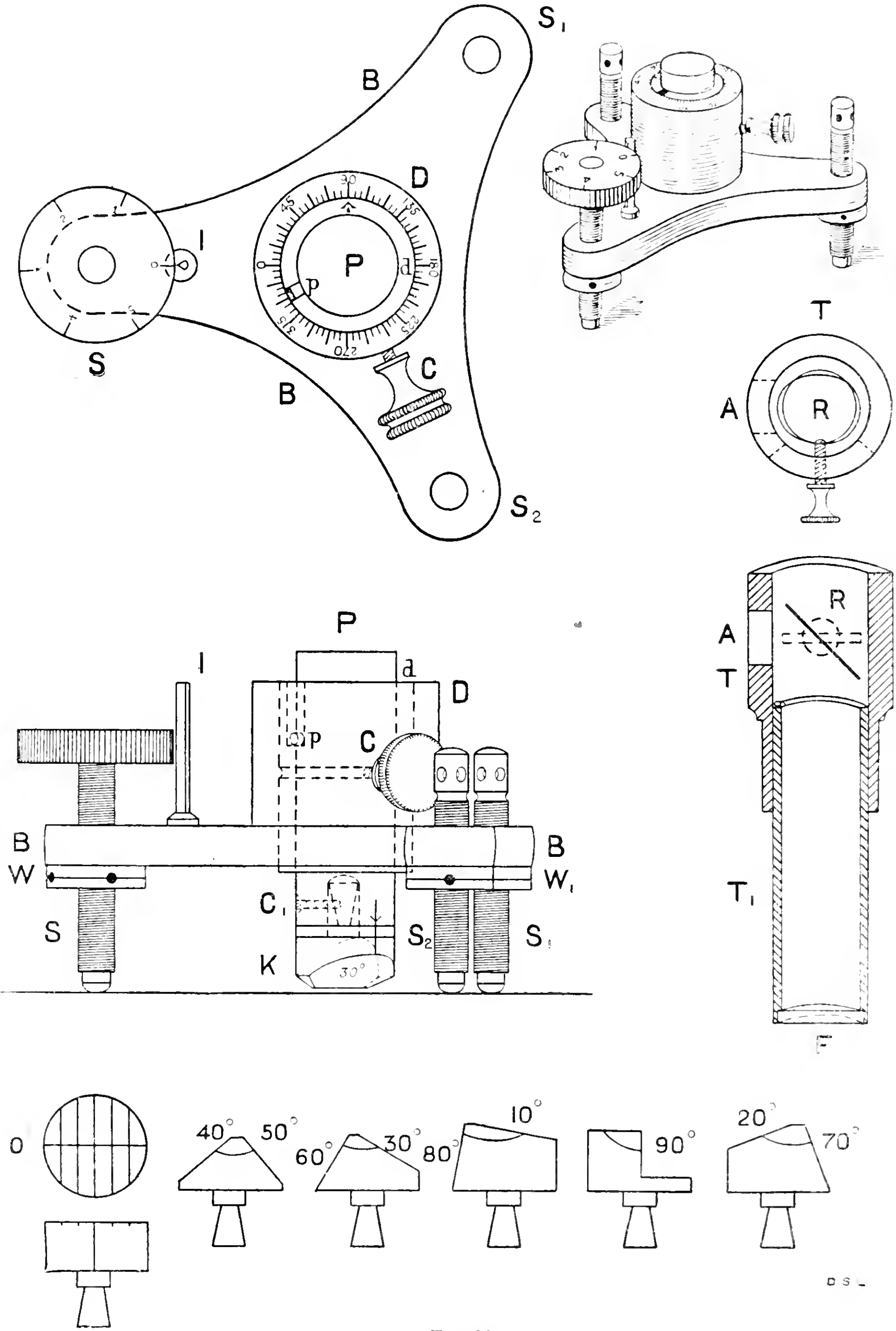

S1
B
D
I
P
p
d
S
B
C
S2
T
A
R
P
I
d
D
p
C
B
W
B
W1
C1
S
S2
S1
K
30°
A
R
T
T1
F
0
40°
50°
60°
30°
80°
10°
90°
20°
70°
D S L

Fig. 32.

axis of the instrument in place of the solid cylinder P. If the apparatus stand on a blackened glass plate and the image of a signal be reflected down the tube, two images may be seen when the eye is placed over the vertical illuminator, one from the optical flat and the other from the blackened glass plate; by turning the screw S these images may be brought into coincidence, and it is found that this method of adjustment is sensitive to 2′ of arc. Plates may thus be cut the surfaces of which do not depart more than 2′ from parallelism. The principle underlying the application of the instrument is that a crystal suitably mounted on any of the holders may be rotated in two directions at right angles to each other, one of the axis of rotation being that of the cylinder P. By means of these two movements it is possible to bring any desired direction in the crystal normal to the grinding surface.

Investigating the Life-history of the Sporozoa of Spatangoids.* Helen L. M. Pixell-Goodrich obtained *Echinocardium cordatum* from Naples, Plymouth, and Port Erin. A little hole is made in each side of the test. The cœlomic fluid can then be poured out into a suitable vessel and examined with a binocular Microscope. Afterwards the inside of the test is carefully washed out with sea-water introduced by a pipette through one of the holes and the washing collected and examined in a similar way. The cysts containing early stages are generally free in the cavity and readily distinguished by their opacity. The cyst walls of those ripe with spores, where not covered with amœbocytes, are so translucent that the spherical mass of crystals shows up with great clearness in the interior. Nearly all the work was done on living parasites, though films and sections were also made. Hot corrosive sublimate and acetic acid mixture fixed the sporozoite nuclei of the ripe spore satisfactorily. In studying differences in the shapes of the tails it was found best to overstain with iron-hæmatoxylin or haematein, which are fairly readily taken up by the epispore, but readily lost again on differentiating with iron alum. Orange G and nigrosin also stain the epispore, but not very easily. Unless well stained the tails are practically invisible in Canada balsam. For rough comparison, Stephen's ink was found very convenient for staining the tails of fresh spores.

(4) Staining and Injecting.

Vital Staining of the Nucleus.†—A. M. Przesmycky used neutral red for staining intra vitam the nuclei of protozoa and metazoa. The nucleus behaved differently. It might stain uniformly; the staining might be irregular, some parts being dark, others light. In a third class, the staining clearly differentiated between the chromatin and the achromatin. It was noticed that all the organisms which stained well during life decolorized directly they died. The results were, that the stained and living nucleus was able to divide, and that after death it decolorized though it remained in the staining fluid. The different substances in the living nucleus stain quite distinctly, e.g. chromatin and achromatin. The living nucleus has a greater affinity for neutral red than the protoplasm, as it stains more strongly and decolorizes more slowly.

* Quart. Journ. Microscop. Sci. lxi., 1915, pp. 81–104 (1 pl.)
† C.R. Soc. Biol. lxxviii. (1915), pp. 83–6.

Metallography, etc.

Alloys of Copper and Zinc.*—L. Guillet reviews recent progress in the knowledge of the copper-zinc alloys, and gives the results of his own investigations upon fifteen alloys in the range 0 to 44 p.c. zinc. The influence upon microstructure, of hot-rolling, of cold-rolling, of annealing, and of quenching from various temperatures, is described.

Deformation of Copper at High Temperatures.†—A. K. Huntington gives results additional to those he has previously published upon the effect of temperatures higher than atmospheric on tensile tests of copper and its alloys. A number of photomicrographs of specimens strained at various temperatures illustrate the author's conclusions.

Coalescence in Steel and in Alloys.‡—A. M. Portevin and V. Bernard discuss the coalescence of constituents of alloys brought about by heat-treatment, and describe the microstructure of specimens of bronze and of steel which had undergone heat-treatments intended to induce the aggregation, into larger masses, of particular constituents. Two copper-tin alloys containing respectively 16 and 25 p.c. tin were heated in a salt-bath to 525° C., cooled (through the eutectoid temperature) in 5 hours to 475° C., rapidly reheated to 525° C., and again very slowly cooled. The δ constituent, originally finely divided, had coalesced into large masses. Steels of eutectoid composition slowly cooled from 800° C. consisted of lamellar pearlite; annealing for 30 hours at 700° C. caused the formation of very perfect granular pearlite, a photomicrograph of which, at 1200 diameters, shows globules of cementite embedded in ferrite. A steel containing 0·5 p.c. carbon, very slowly cooled from 800° to 700° C., and more rapidly below that temperature, contained no granular pearlite. Coalescence had begun in a specimen slowly cooled from 800° to 700° C., maintained at 700° C. for 10 hours and then air-cooled, while complete coalescence had occurred in a specimen annealed for 30 hours at 700° C. and air-cooled, the steel then consisting of free ferrite and granular pearlite. Re-solution of the cementite does not occur in granular pearlite immediately on passing the critical point on heating, but requires a certain duration of heating above the critical point.

Electrolytic Iron.§—L. Guillet deals with the manufacture, properties, and uses of very pure electrolytic iron, and describes its microstructure. On removal from the electrolyte bath the material is hard and brittle, and consists microscopically of innumerable fine needles, much resembling martensite. This structure does not disappear at 300° C., but it fades as the temperature rises, and disappears entirely

* Rev. Métallurgie, xi. (1914) pp. 1094–1132 (26 figs.).
† Journ. Inst. Metals, xii. (1914, 2) pp. 231–253 (20 figs.).
‡ Journ. Iron and Steel Inst., xc. (1914, 2) pp. 204–212 (17 figs.).
§ Journ. Iron and Steel Inst., xc. (1914, 2) pp. 66–81 (12 figs.).

at about 800 to 900° C. After annealing at 900° C. the structure is normal for pure iron, and the metal is soft and ductile. During the heating, hydrogen and smaller quantities of other gases are evolved.

Slag Inclusions in Steel.*—Specimens of acid steel and of basic steel were rapidly cooled from the liquid state, and microscopically examined by F. Giolitti and G. Tavanti. The same specimens were again examined after annealings followed by rapid cooling, and by slow cooling. The various treatments had no appreciable influence upon the form and distribution of the inclusions of reaction slag, and the authors conclude that such slag inclusions are not dissolved in the molten steel. The behaviour of reaction slag appears to be different from that of inclusions consisting mainly of sulphides of manganese and iron.

Mechanical Anisotropy of Metals.†—A. Portevin discusses the irregularity of form of the impression made by the ball in Brinell tests upon metallic specimens in which the crystals and the impression are of the same order of magnitude. Each crystal is anisotropic, and its mechanical properties are a function of direction relative to the crystal structure. When the area affected by the test contains a very large number of crystals, each independent in its orientation, as is commonly the case, the various crystals neutralize each other as regards their anisotropic properties, and approximately circular impressions are obtained. An impression wholly contained within one crystal tends to be square with rounded corners. The form of impressions covering a small number of adjacent crystals, of similar or different orientation, is described.

Some Metal Failures in Plant.‡—S. Evans describes a number of failures occurring in an engineering works, the causes of which were ascertained by microscopic examination of the faulty metal. A steel crosshead of a gas-engine, containing 0·37 p.c. carbon, was considered to have failed owing to its coarse structure, of the Widmanstätten type, which might have been removed by suitable heat-treatment.

* Ann. Chim. Appl. ii. (1914) pp. 360–366, through Journ. Soc. Chem. Ind. xxxiv. (1915), p. 179.

† Comptes Rendus, clx. (1915) pp. 344–6.

‡ Journ. Soc. Chem. Ind. xxxiv. (1915) pp. 204–207 (8 figs.).

PROCEEDINGS OF THE SOCIETY.

MEETING

HELD ON THE 21ST OF APRIL, 1915, AT 20 HANOVER SQUARE, W., MR. D. J. SCOURFIELD, F.Z.S., ETC., VICE-PRESIDENT, IN THE CHAIR.

The Minutes of the Meeting of March 17th were read and confirmed, and signed by the Chairman.

The following Donation received since the last Meeting was announced, and the best thanks of the Society were voted the donors :—

	From
Beale (Sir Wm. P.), An Amateur's Introduction to Crystallography, 1915	*Messrs. Longmans, Green & Co.*

Mr. E. Heron-Allen, F.L.S., F.R.M.S., etc., gave a lantern demonstration of slides illustrating some newly observed phenomena in the Bionomics of the Foraminifera, which have recently been brought before the Royal Society by the Author and form the subject of a paper now in the press for the Philosophical Transactions. The main points touched upon were :—1. The mechanical functions of protoplasm as illustrated by the locomotion of the Foraminifera and their capture and ingestion of food. 2. The question of reproduction by budding as distinct from the phenomenon hitherto known as plastogamy. 3. The evidence afforded by many of the Foraminifera in the construction of their shells of phenomena of the purpose and intelligence with which the speaker claimed that the Protozoa are endowed. A new feature in the life-history of *Cymbalopora tabellæformis* Brady, viz. its powers as a burrowing or encrypting organism, was also illustrated by slides. A number of later and more highly perfected skiagraphs of Foraminifera made by Mr. J. E. Barnard, F.R.M.S., were also shown.

The Chairman, in thanking Mr. Heron-Allen for his communication, said he was sure all would agree that the debt of gratitude which the Society already owed to the author had been greatly increased by his extremely interesting communication that evening. It was a paper conveying a large number of important points, some of which, especially in the concluding portion, were evidently of a somewhat controversial nature. The illustrative photographs were particularly fine, those taken by Mr. Barnard by means of X-rays being of quite exceptional

value, seeing that they gave details of internal structure in opaque microscopic organisms without in any way damaging the shells.

Mr. Thomas H. Hiscott suggested that it would be of interest to hear what Mr. Earland had to say upon such highly controversial matters.

Mr. Earland replied that he was sure the Meeting would not wish him at that hour to enter into a discussion with his colleague, on a subject which they had debated for several years, beyond saying that he had not in any way altered his own views on Plastogamy since he wrote some brief remarks on the subject in 1905 in the Journal of the Quekett Microscopical Club.

That there were instances of "associated" pairs was unquestionably true ; but how was one to distinguish "associated" pairs from plastogamic pairs when they had nothing but dead shells to work on ? That was a point which neither he nor his colleague, nor anyone else, was in a position to decide.

As regards the question of Skiagraphy applied to the study of the Foraminifera he was not impressed with the belief that it would lead to new discoveries of structure, and on this point he differed greatly from his colleague, who was an optimist. He himself was content to accept the remarkable results obtained by Mr. Barnard without building any hopes on a further advance, and, whilst appreciating the results, failed to see how any great advance upon what had been done up to the present was to be obtained until physical laws were altered. It was simply going back to the old days of deep eye-pieces, as there was no increase in aperture. He failed to see how the optimistic expectations based on Mr. Barnard's work were to be justified, although no one would be more pleased than himself if these hopes were fulfilled. As the process stood at present it answered splendidly for the larger forms, although even here it broke down over the microspheric types, because the minute and numerous early chambers would not stand the magnification of the image on the negative. With the smaller species the process at present broke down absolutely, for the same reason.

Mr. Barnard regretted that he was at a great disadvantage as he had only heard the concluding portions of Mr. Earland's remarks, but he believed that Mr. Earland failed to appreciate the point of view from which he had taken up his work with X-rays. Mr. Earland was evidently under the impression that the sole aim and object was to obtain radiographs of Foraminifera, but this was a mere incident in the work. He absolutely disclaimed any intention whatever to regard these results as final—they could hardly be considered even a step in the process which he had in view—so that it was not quite fair to pass judgment upon the subject, and he (Mr. Barnard) thought that what he had said previously should be recalled to mind. Since the meeting at which he showed his photographs he had done further work, which was not without promise, but he was unable to go further than this at present.

Mr. Earland was correct in saying there was not increase in resolution by the method of using X-rays of which the results shown were examples. The whole point was that if it became possible to utilize radiations of

shorter wave-length than those at present used, on ordinary physical grounds it should be possible to obtain increased resolution. These possibilities were clearly defined in the original paper, and no claims were made other than those to be expected on theoretical grounds.

Dr. Shillington Scales said that he was not sorry to have an opportunity of making a remark, if Mr. Heron-Allen would forgive him. The latter had been speaking with much hope of the future of X-rays as applied to microscopy, but he thought it wise to utter a word of warning. Mr. Barnard had also allowed himself to indulge in some flights of anticipation in regard to the future, but Mr. Barnard would probably agree with him that at the present time there was no sign of the realization of this hope. Granted that X-rays were of exceedingly short wave-length, they could not utilize such wave-lengths until they succeeded in getting adequate magnification for the purpose, and though they had succeeded under favourable conditions in reflecting and in a sense "refracting" X-rays, at present such refraction and reflection was much too small to enable one to count with any confidence on being able to obtain the high magnification required to use X-rays as a means of "resolution," and it remained a fascinating speculation. Before sitting down he wished to thank Mr. Heron-Allen for the beautiful slides he had shown that evening, and for the interesting demonstration he had given.

Mr. Rheinberg said that as regards the controversy concerning Mr. Barnard's paper, he thought that there was a good deal of misconception about, which might be avoided if it were remembered that that paper, as he understood it, consisted of two water-tight compartments—the one dealing with the possibilities for increasing the resolving power of the Microscope, which X-rays, owing to their short wave-length and their newly established optical properties, opened out; the other dealing with an improved method of producing skiagrams of microscopic objects.

As to the first, despite the great difficulties to be overcome, it appeared to him a perfectly safe prophecy that the future of microscopy so far as concerns increased resolving power would move in that direction.

As regards the second, it was Mr. Pierre Goby who had, he believed, been the first to make micro-radiograms of Foraminifera and other microscopic objects, and a report of his paper, together with illustrations, would be found in their own journal.* Mr. Barnard had considerably improved on Goby's methods, as the remarkably fine results showed. Their value had been demonstrated in the course of Mr. Heron-Allen's most interesting demonstration, but it lay in quite other directions than that of resolving power, which the method in question never aimed at. In regard to that particular point he was in agreement with Mr. Earland that it amounted to the same thing as high eye-piecing.

Dr. J. Rudd Leeson pointed out the wonderful thought and light which had been thrown upon this "conscious" process by what they had just seen and heard. There were two kinds of acts; there was the act without purpose and the act with a purpose—the act of a baby moving its legs and of a man in a fit was without purpose; but all other living

* Journ. Roy. Micr. Soc., 1913, p. 373, pl. xvii.

motions have purpose as their end. It seemed to him that we could not deny that these little organisms, low and insignificant as they might be, were imbued with a fraction of the same kind of intelligence as we ourselves possess. It was to him extraordinary and mysterious, but he was certain that Mr. Heron-Allen was right in suggesting that if we wanted to get on sound lines we must entirely disabuse our minds of old-fashioned ideas. To him the superstition that there was a something which came into a man when he was born, and a something which went out of him when he died, was a survival of primitive ideas and unsupported by science; conciousness was a growth, an evolution, a property of living protoplasm.

One could only say with Herbert Spencer that it was "a special and individual form of energy." What one meant by "energy" it was impossible to say. Personally he looked upon the Microscope not as a scientific toy—to him it was an agent by which one could penetrate a little further into these wonderful and fundamental mysteries.

Mr. Julius Rheinberg, F.R.M.S., read a paper on "A Simple Form of Spectroscope and Micro-spectroscope." At the conclusion he was asked by Mr. Barnard whether he could say how the amount of light in his spectra compared with that obtained with, say, a Browning Micro-spectroscope. To this he pointed out that as he was utilizing the first spectrum of a diffraction grating, the light in the spectrum would be something less than one-fourth of that of the incident light. But the amount of light was quite sufficient; there was no trouble in use on that score.

It was announced that the next Ordinary Meeting would take place Wednesday, May 19, when the Annual Exhibition of Pond-life would be held.

The Chairman further announced that the next Meeting of the Biological Section would be held on Wednesday, May 5, when Mr. J. Burton would communicate some Notes on Blue-Green Algæ.

The following Instruments, etc., were exhibited:—

Mr. Julius Rheinberg:—Simple Forms of Spectroscopes; Simple Form of Micro-spectroscope.

New Fellows:—The following were elected *Ordinary* Fellows of the Society: Arthur Baker, William Beattie, John Francis Donald Tutt, M.R.C.V.S.

MEETING

HELD ON THE 19TH MAY, 1915, AT 20 HANOVER SQUARE, W., MR. JOHN HOPKINSON, F.L.S. F.G.S., ETC., VICE-PRESIDENT, IN THE CHAIR.

The Minutes of the Meeting of April 21, 1915, were read and confirmed, and signed by the Chairman.

The Secretary announced that he had received a telegram from the President, Professor G. Sims Woodhead, M.A. M.D., saying he hoped to get away in time for the Meeting, but was kept at the last moment making arrangements for a number of wounded soldiers.

Dr. Malcolm Burr, D.Sc. F.E.S., contributed a paper "On the Male Genital Armature of the Dermaptera," which, on account of its technical character, was taken as read.

The Chairman remarked that as Dr. Malcolm Burr's memoir was not read, even in abstract, it could not be commented upon, but the Members present might be interested in hearing something about the author. An engineer by profession, Dr. Burr had devoted all his spare time for some years to the study of entomology, especially the earwigs. He had visited nearly all the Natural History Museums of Europe, and others beyond our continent, to study their collections, and he had been greatly helped in doing so by being an accomplished linguist, speaking many European languages, including that of Russia—which is the most difficult of all—where he is now residing. He had nearly completed an extensive monograph on the "Earwigs of the World," which has been accepted for publication by the Ray Society, and had it not been for the present war the first part would probably have appeared this year, but it was thought to be an inauspicious time to commence the publicatiin of such a work, costing, as it would do, several thousand pounds to produce. As Dr. Burr is generally acknowledged to be our chief authority on these interesting if not very attractive insects, it may be anticipated that the present memoir will be indispensable to all students of the group.

The Chairman added that he had another memoir of Dr. Burr to find a congenial home for, but as it was the result of a critical examination of the Dermaptera in the Berlin Royal Zoological Museum, written in German, he felt assured that it was hopeless to expect it to be published either in England or in Germany (if it could be got there) under the present circumstances.

A hearty vote of thanks was accorded to the author for his valuable contribution to the Society's Transactions.

It was announced that the next Ordinary Meeting would be held on Wednesday, June 16, and that of the Biological Section on Wednesday, June 2.

It was further announced that a visit would be paid on Saturday, June 5, to the John Innes Horticultural Institution, Merton, by the kind permission of Professor Bateson.

The Chairman, in announcing that the rest of the evening would be devoted to the Pond-life exhibits, proposed that a hearty vote of thanks be accorded those Fellows of the Society and Members of the Quekett Microscopical Club who had contributed to the success of the evening by bringing before them such a fine collection of material.

The vote of thanks was carried with acclamation by the Fellows present.

The following Objects were exhibited:—

Mr. W. Baddeley	*Chydorus sphæricus.*
Mr. W. E. Watson Baker	*Hydra viridis*; *Paramæcium aurelia*: *Hydatina senta.*
Mr. C. H. Bestow	*Vorticella.*
Mr. N. E. Brown	*Cymbella cistula*, reproduction.
Mr. Thomas N. Cox	*Spirogyra*, in conjugation.
Mr. Daniel Davies	*Daphnia pulex*; *Hydra viridis.*
Mr. G. K. Dunstall	*Ophrydium versatile* var. *viridis.*
Mr. H. E. Freeman	*Caddis* larvæ, etc.; a very young newt, showing circulation, etc.
Mr. James Grundy	*Vorticella*; *Melicerta*; *Paramæcium*, etc.
Mr. A. E. Hilton	Germinating swarm-spores of *Reticularia lycoperdon* (Mycetozoa).
Mr. G. F. Hook	Hydrachnidæ, from Richmond Park.
Mr. H. E. Hurrell	Polyzoa, including *Lophopus crystallinus.*
Dr. J. Rudd Leeson	*Spirogyra.*
Mr. J. Milton Offord	*Dendrocomella paradoxus* on gill-plates of *Gammarus.*
Mr. Robert Paulson	Pond-snail eggs.
Mr. Thos. H. Powell	Cyclosis in *Vallisneria*, shown with $\frac{1}{40}$ apochromatic oil-immersion.
Mr. John Richardson	Pond-snail eggs.
Mr. G. H. J. Rogers	*Hydra viridis.*
Mr. C. F. Rousselet	*Stephanoceros Eichhornii*; Pond-snail eggs.
Mr. R. S. W. Sears	*Asplanchna priodonta.*
Mr. A. E. Smith	Young newt, showing circulation of blood.
Mr. T. J. Smith	*Hydra viridis.*
Mr. G. Tilling	*Plumatella repens.*
Mr. C. S. Todd	Rotifers, etc., from the river Lea.
Mr. W. R. Traviss	*Stephanoceros Eichhornii.*
Mr. Joseph Wilson	*Hydra viridis*; *Lophopus crystallinus.*

JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

AUGUST, 1915.

TRANSACTIONS OF THE SOCIETY.

VI.—*The Dawn of Microscopical Discovery.*

By Charles Singer.

(*Read January* 20, 1915).

Figs. 33 to 48.

The history of microscopical discovery may be conveniently divided into three main epochs:—

1. The *Pioneer period*, extending to about 1660.
2. The *Classical period*, covering half a century or more from about 1660, and including the work of the great microscopists, Hooke, Grew, Malpighi, Leeuwenhœck and Swammerdam.
3. The *Modern period*, dating from the optical discoveries of Newton.

It is with the first of these periods that we shall mainly deal in the following pages.

The earliest microscopical observation known is that of Seneca (circa A.D. 63), who in his "Quæstiones Naturales" assures us that "Letters, however small and dim, are comparatively large and distinct when seen through a glass globe filled with water."* This is, however, an isolated observation.

The properties of curved reflecting surfaces, and even to some extent of lenses, were known to the ancients, and to some mediæval writers, such as Roger Bacon.† The invention

* Lucius Annæus Seneca, "Quæstiones naturales," Lib. i., ch. 6.

† For Roger Bacon's knowledge of optics see "The 'Opus Majus' of Roger Bacon, with Introduction," by J. H. Bridges, Oxf., 1897, p. lxix. ff., and parts iv. and v. of the "Opus Majus" itself. Also E. Wiedemann and S. Vogl in "Roger Bacon, Essays . . . collected and edited by A. G. Little," Oxf., 1914.

of convex spectacles is attributed to Salvino d'Amarto degli Armati, of Florence, and to Alessandro de Spina, of Pisa, about the year 1300, and these aids to vision were familiar to many throughout the fourteenth, fifteenth and sixteenth centuries.* During this period the optical properties of lenses were investigated by the penetrating genius of Leonardo da Vinci (1452–1519),† and by the mathematical skill of Maurolico (1494–1575),‡ while convex spectacles must have been on the nose of many a careful illuminator of manuscripts. It is yet an extraordinary fact, and one which requires further explanation, that there is no single instance on record of these glasses having been used for the investigation of nature. Many illuminated manuscripts of the fifteenth and sixteenth centuries, especially those of the Flemish school, betray the most exquisite care in draughtsmanship; notably, the marginal decorations often involve figures of insects and flowers showing the greatest skill in portrayal. Yet these figures never suggest the use of a magnifying glass to reveal any detail of the object drawn, while it is often hard not to believe that such an aid to vision must have been used in guiding the minutely accurate movements of the artist's pen or brush.

Fig. 33.—Enlarged figure of fly, as drawn by Hœfnagel, 1592.

The first illustrated publication for whi h there is evidence of the use of a magnifying glass appeared in the year 1592, at Frankfort, bearing the name of George Hœfnagel (1545–1600).§ The volume consists merely of a series of plates engraved on copper, illustrating

* On the subject of the invention of spectacles see Hörner, "Ueber Brillen aus alter und neuer Zeit," 1885; P. Pansier, "Histoire des Lunettes," Paris, 1901; E. Bock, "Die Brille und ihre Geschichte," Vienna, 1903; Du Bois-Raymond, "Zur Geschichte der Glass Linsen," 1905; Hirschberg, in "Geschichte der Augenheilkunde," Leipz., 1906: Buch 11, Teil 2; B. Laufer, in "Mitteilungen zur Geschichte der Medizin und Naturwissenschaften, 1907, vi. p. 379; E. H. Oppenheimer, "Der Erfindung der Brille," in Zentralzeit, f. Optik u. Mechanik, 1908, p. 13; R. Greef, "Die altesten uns erhaltenen Brillen," in Arch. f. Opthal. Wiesb., 1912, lxxii., pp. 44–51. The role of Salvino d'Amarto and Alessandro de Spina has been recently re-discussed by Vincenzo Rocchi, "Appunti di Storia Critica del Microscopio," in the Rivista di Storia Critica delle Scienze Mediche e Naturali, January, 1913, anno iv., No. 1, p. 4 ff, and by G. H. Oliver, in the Brit. Med. Journ. 1913. It has been alleged that in the thirteenth century, and even earlier, spectacles were in use among the Chinese. On this point see Hirschberg in "Mitteilungen zur Geschichte der Medizin," 1907, vi. p. 550.

† On Leonardo's knowledge of optics see Otto Werner, "Zur Physik da Vincis," Berlin, 1911, p. 142.

‡ Francesco Maurolico, "Photismi de lumine et umbra ad perspectivam radiorium incidentium facientes," Venice, 1575.

§ The title-page is worded as follows: "Archetypa studisque patris Georgii Hoefnagelii. Jacobus F. genio duce ab ipso scalpta, omnibus philomusis amice D: ac perbenigne communicat. Ann. Sal: XCII. Aetat XVII. Frankfort a/M."

common objects of nature, but drawn with exceptional skill and minute and faithful accuracy Some few of these drawings reveal enlarged details which would have been hardly distinguishable to the unaided eye. These remarkable figures are stated to

FIG. 34.—Fabio Colonna. From his botanical work published in 1606.

have been the work of Hœfnagel's son, Jacob (1575), then a youth of seventeen. One of them, the draught of a magnified domestic fly, we here reproduce (fig. 33).

Another early naturalist who seems to have made use of the

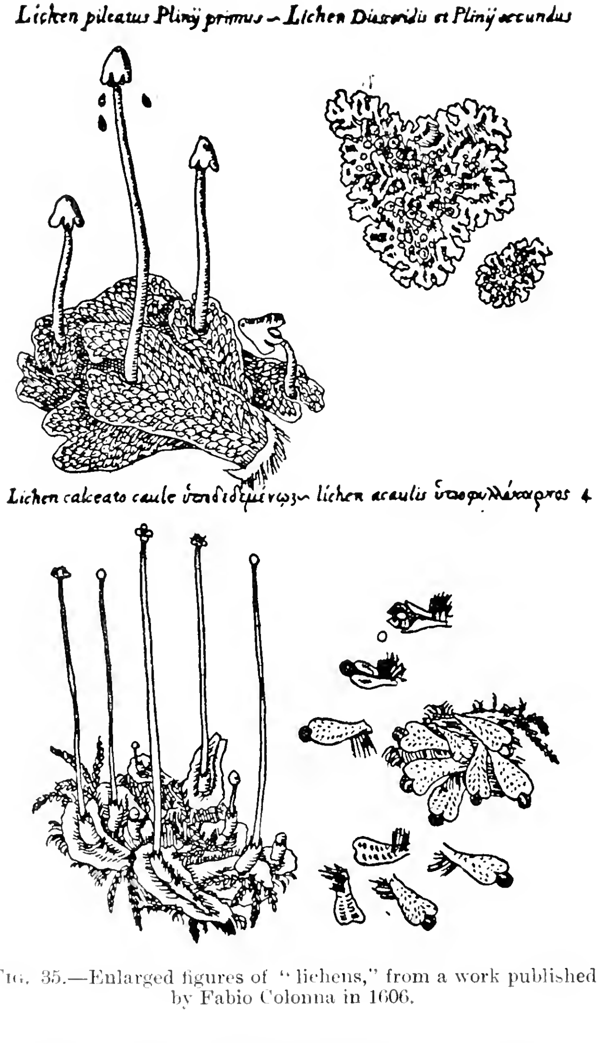


Fig. 35.—Enlarged figures of "lichens," from a work published by Fabio Colonna in 1606.

magnifying glass is Fabio Colonna, an excellent botanist, and one of the original members of the Academy of the Lynx at Rome. Colonna gives in his works numerous enlarged details of plants, and in the figure of the "lichens," here reproduced to the original

scale, a considerable degree of magnification has been adopted* (fig. 35).

The occasional use, however, by a naturalist of a simple lens of low magnifying power could have but little influence on the advance of knowledge. Not until the classical period with the invention of lenses of very short focus did the simple Microscope become a valuable means of research. In the pioneer period it was rather the discovery that lenses could be combined into Telescope and Microscope that gave the first stimulus to investigation. These compound instruments were invented about the year 1610, but whereas the telescope was at once industriously and systematically employed by workers of commanding power, the Microscope was less happy in its advocates, and observations were few scattered and unrelated to each other.†

In order to give an idea of the course of development of microscopic knowledge, we will first make an historical survey of the knowledge of a particular organism, extending rather beyond the limits of our period, and we will return later to a chronological account of the best pioneer work in other fields. The type organism we select is the little Acarus that produces the disease known as "Scabies" or the "Itch."

The History of the Itch-Mite.

The Itch-mite or *Sarcoptes scabiei* is just within the limits of unaided vision. The largest specimens sometimes attain to a size of about 450 μ by 350 μ. These little Acari burrow in the skin, commencing usually in the hands—whence their name, "Hand-worms,"—and spreading thence over the body, they cause intense itching and give rise to a characteristic rash.

The disease is now a comparatively trivial condition, cured with certainty by change of raiment and externally applied sulphur preparations. Before this rational treatment became general, however, the malady was frequently grave and occasionally fatal, and was treated either ineffectually by internal remedies or laboriously and partially by pricking the little burrows and extracting the organisms separately with a needle. This was a process that required patience and faith on the part of the sufferer, and on the part of the operator (usually a woman) the same qualities with the addition of exceptionally good near vision. "How cruel a disease

* Fabio Colonna. "Minus cognitarum stirpium aliquot ac etiam rariorum nostro coelo orientium ἐκφρασις," Rome, 1606. The description of the lichens figured is on p. 331 of this work.

† The present writer has given a general review of the early history of the instrument in his "Notes on the Early History of Microscopy," Proceedings of the Royal Society of Med. 1914, vol. vii. (Section of History of Medicine), pp. 247 79.

is this," exclaims Thomas Mouffet, an English naturalist of the sixteenth century, "An honourable English lady of sixty years . . . the most vertuous lady of Penruddock, a knight . . . was for ten years troubled with these wheal-worms; with which night and day she was miserably tortured in her eyes, lips, gums, soles of her feet, head, nose, and all her parts, that she lived a very grievous life, alwaies without rest, and at last in despite of all remedies, the disease increased, whereby her flesh was consumed, and she died thereof. I must not overpass this, that the more the women that sat by her picked them out with their needles, the more their young ones bred." *

Thomas Mouffet had closely observed the organism, and from certain indications in his writings we are led to believe that he had used a magnifying glass for the purpose. In his "Insectorum Theatrum," the printed editions of which do but the scantiest justice to the beauty and minute accuracy of the original illustrations, he tells us that the Acarus "is the smallest living creature that is, which useth to breed in old cheese and wax, and also in man's skin . . . It dwells so under the skin that when it makes its mines it will cause a great itching, especially in the hands and other parts affected with them and held to the fire. If you pull it out with a needle, and lay it on your nail, you shall see it move in the sun that helps its motion; crack it with the other nail, and it will crack with a noise, and a watery venome cometh forth; it is of a white colour, except the head; if you look nearer it is blackish, and from black it is something reddish. It is wonder how so small a creature that creeps with no feet, as it were, can make such long furrows under the skin. This we must observe by the way, that the Syrones [i.e. Acari] do not dwell in the pimples themselves but hard by." †

Mouffet's work, though completed in 1589, was not published during his lifetime, but was brought out in 1634 by Sir Theodore Touquet de Mayerne. The distinguished Huguenot physician adds a preface of his own, in which he tells us how he was accustomed to observe small creatures by means of magnifying glasses. "If you take," says Mayerne, "lenticular optick Glasses of crystal (for though you have Lynx his eyes, they are necessary in searching after Atoms) . . . you will admire to see . . . the Fleas that are curasheers, and their backe stiffe with bristles, their legs rough with hair, and between two foreyards there stands a hollow trunk to torture men, which is a bitter plague to maids . . . You

* Thomas Mouffet, "Insectorum sive Minimorum Animalium Theatrum." The original MS., completed in 1589, is now in the British Museum (Sloane MS., 4014). It fell into the hands of Mayerne and was published by him in 1634. Our quotations are from a charmingly translated English version of the work and of Mayerne's preface that appeared from the hand of J(ohn) R(owland) in 1658, as "The Theatre of Insects or Lesser Living Creatures."

† Mouffet, loc. cit. pp. 1094 and 1095.

shall see the eyes of the Lice sticking forth, and their horns, their bodies crannied all over, their whole substance diaphanous, and through that, the motion of their heart and bloud as if it floted in Euripus . . . *Also little Handworms which are indivisible they are so small, being with a needle pickt forth of their trenches neer the pools of water which they have made in the skin, and being laid upon ones nail, will discover by the Sunlight their red heads and feet they creep withal.*" *

The little Acarus was well known to the philosopher René Descartes (1596–1650), who interested himself greatly in optical methods, and also to his pupil Rohault (1620–1675).† It is

Fig. 36.—Thomas Mouffet, from a Manuscript in the British Museum (Sloane, 4014).

frequently mentioned by early writers as illustrating the extreme complexity of minute nature, and as representing the smallest possible living form, indivisible in its minuteness and a veritable "living atom," a term often applied to these minute organisms by sixteenth and seventeenth century writers.‡

The conception is illustrated in a curious passage by the verbose

* Mouffet, loc. cit. The Epistle Dedicatory.

† Jacques Rohault. "Traité de Physique," Paris, 1671.

‡ It is interesting in this connexion to observe that the word mite is probably derived from a Gothic root *mei*, to cut or divide; thus the words *mite* and *atom*, which in the seventeenth century were often interchangeable, have really a similar connotation. Both words imply a fragment of matter so far broken up that its further division is impossible.

Walter Charleton (1619–1707), one of the founders of the Royal Society. Charleton asks us to "Consider the delicate contexture of the Atoms in the Body of that smallest of animals, a *Handworm*. First, if we speculate the outside of that organical tenement of life, a good Engyoscope [i.e. Microscope] will praesent our eyes with not only an oval head, and therein a mouth, or prominent snout, armed with an appendent proboscis, or trunk consisting of many villous filaments contorted into a cone, wherewith it perforates the skin and sucks up the blood of our hands, but also many thighs, legs, feet, toes, laterally ranged on each side; many hairy tufts on the tail, and many asperities and protuberances. Then our reason if we contemplate the *inside* thereof, will discover a great variety of organs necessary to the several functions of such an Animal."*

The first to publish a figure of the Acarus of scabies was the quaintly superstitious writer, August Hauptmann, in the course of a work on Baths, published in 1657. Hauptmann had discovered that certain natural baths (doubtless containing sulphur) were remedial against the itch. He knew that the Acarus burrowed in the thickness of the human skin, and he tells us that "these vermicules, as far as I could make them out clearly under the Microscope, presented to my eyes a monstrous form with many long tails sticking out behind. My unskilled pen may thus construct a rough sketch thereof" (fig. 37). He goes on to narrate that "the outline and aspect of these creatures are similar to those of the worms called by the Germans Mölben, which are frequently generated like hairy dust in cheeses." † The comparison of the Acari of scabies with those of cheese is perfectly just, and had been made by Mouffet and other earlier writers. That similar minute organisms might be the cause of the disease had already been suggested by Hauptmann in a pamphlet published a few years earlier,‡ in which he assured his readers that fevers were caused by such "worms or their eggs, and that very minute and almost invisible animalcules are the cause of all deaths in men and animals. The creatures are minute wormlets beyond the

FIG. 37.—*Sarcoptes scabiei*, as pictured by August Hauptmann, 1657.

* Walter Charleton, "Physiologia Epicuro—Gassendo—Charltoniana, or A Fabrick of Science Natural upon the Hypothesis of Atoms." London, 1654, p. 115.

† August Hauptmann, "Warmer Badt und Wasser Schatz," Frankfort a/M, 1675, p. 200. The volume contains more than the title implies, and includes reprints and tractates jumbled together in a way that makes a complete bibliographical description difficult.

‡ August Hauptmann, "Epistola praeliminaris, Tractatui de viva mortis imagine," Frankfort a/M, 1650. The work to which this was a preliminary was never issued.

reach of the unaided senses. . . . . Animalcules," he reiterates, "(Cridones sive Dracunculi), insects, moths and little corroding malignant worms and acari * swarm in the discharges and humours of measles, scabies and smallpox, and both give rise to the lesions and cause their ruptures." This, one of the earliest adumbrations of the germ theory of disease, thus carries the analogy of scabies to the somewhat similar rashes of other infectious diseases. The same idea was taken up by Hauptmann's contemporary, Athanasius Kircher, and was pushed to the most absurd lengths in the following century by Linnæus and his pupils.†

The theory of the relationship of Acari to scabies was received

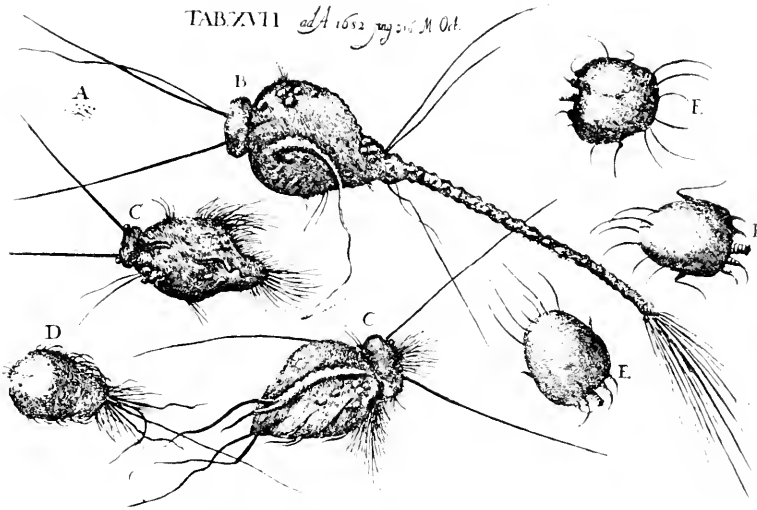


Fig. 38.—*Sarcoptes scabiei*, as figured by Ettmuller in the "Acta Eruditorum" of 1682. The three figures on the right marked E are Ettmuller's own; the others are copied by him from Heintke's work of 1675. The dots at A are supposed to represent the natural size of the creatures.

by most of Hauptmann's contemporaries with scepticism, but in 1675 one Heintke,‡ produced fearsome figures of hairy creatures that he declared to be magnified images of mites extracted from the vesicles of the disease. These monsters were probably at least in part the contents of the sebaceous glands, or black heads, with

* Among these early microscopic writers Cridones, Syrones, Dracunculi, Vermiculi, Bestiolæ, Animalcula, Acari are often mere synonyms.

† Linnaeus: see "Fauna Suecica," 1746; also Michael Baeckner in Thesis "Insectorum," Holm, 1752, and Johannes Nyander in Thesis "Exanthemata Viva." Upsala, 1757.

‡ "Valetudinarium infantile pro publica perlustratione, consensu gratiosae facultatis mediae apertum a praeside Michaele Ettmullero . . . Respondente Georgio Heintke," Leipsig, 1875.

which the *Sarcoptes* had been frequently confused. A few years later this alarming aspect of the affection was somewhat modified by the well-known medical writer Ettmuller (1644–1683), who in 1682 figured tortoise-like organisms that may be recognized as caricatures of our Acarus* (fig. 38).

The terrors of the learned world, perhaps allayed by Ettmuller,

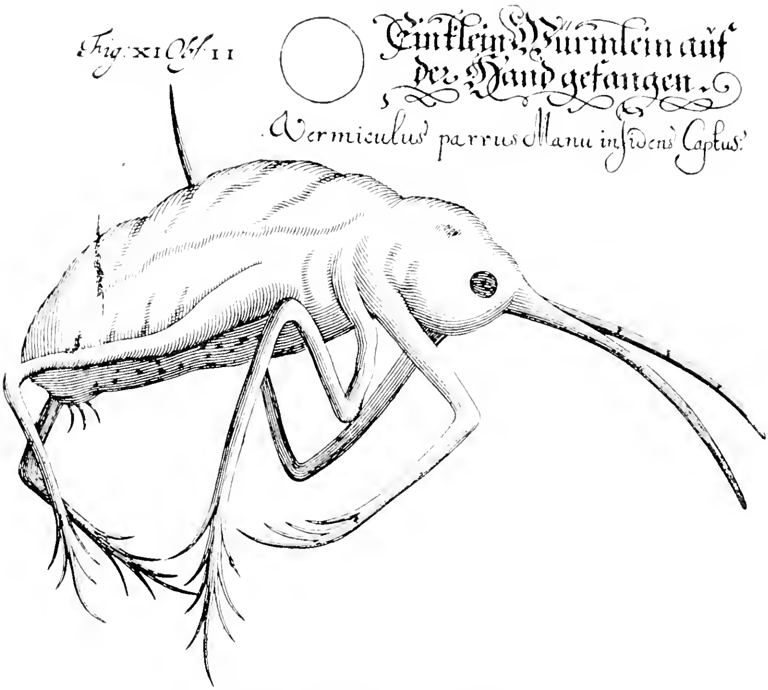


FIG. 39.—*Sarcoptes scabiei*, from the "Micrographia Nova" of Griendelius, 1687.

must have been raised to the highest pitch in 1687 by the ingenious Griendelius, who in his "Micrographia Nova"† presents to us a hideous monster well calculated to disturb the rest of the most phlegmatic of patients (fig. 39). For the fears of such sufferers, however, deliverance was at hand. Later in the same year the *Sarcoptes scabiei* was drawn in truer proportions by two Italian writers, Bonomo and Cestoni (fig. 40) in a letter to the poet-naturalist Francesco Redi.‡ From that work dates the modern knowledge of

* Michael Ettmuller in "Acta Eruditorum," Leipsig, 1682, p. 316.

† Johan Francis Griendelius, "Micrographia Nova," Nuremburg, 1687.

‡ "Osservazioni intorno ai pellicelli del corpo umano fatte dal Dottor Gio. Cosimo Bonomo e da lui con altre osservazioni scritte in una Lettera all' Illustriss. Sig. Francesco Redi," Florence, 1687.

the organism. Bonomo and Cestoni attained to a correct idea of the nature of the *Sarcoptes*, its life-history and its rôle in the disease. Beyond this point we need not trace in detail the history of our knowledge of the organism.

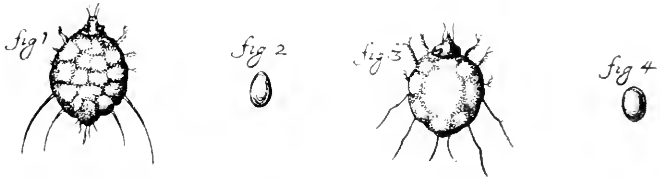


Fig. 40.—*Sarcoptes scabiei* and their eggs, from the "Osservazioni intorno ai pellicelli" of Bonomo and Cestoni, 1687.

Gradually among scientific writer the *Sarcoptes* became accepted as the cause of the itch, and although doctors waited for another hundred years before they were convinced by their colleague Wichman (1740–1802),* we can yet say that by Bonomo and

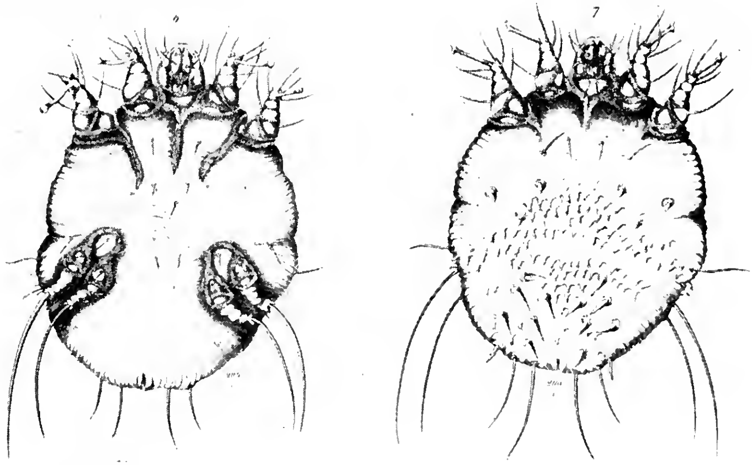


Fig. 41.—Dorsal and ventral aspects of *Sarcoptes scabiei*, from Fuerstenberg.

Cestoni the organic cause of an infectious disease was for the first time scientifically demonstrated. Those who would learn of the subsequent progress of our knowledge of the subject may be referred, with the writer's sympathy, to the monumental work of

* Johann Ernst Wichmann, "Aetiologie der Krätze," Hanover, 1786.

Fuerstenberg,* who devotes some 170 closely printed folio pages to the bibliography of this organism alone (fig. 41).

We may now revert to the more general development of microscopic knowledge. The earliest observation with the compound Microscope that has come down to us is by Galileo himself, and is preserved in a work by the Scot, John Wodderborn, dated 1610. It shows that the great astronomer had even at that date an idea of the compound character of the eyes of insects. "A few days back," says Wodderborn, "I heard the author himself [Galileo] narrate to that noble philosopher, the most excellent Signor Cremonius, various things worthy to be known, and among others how he perfectly distinguished with his telescope [perspicillum] the organs of motion and of sense in the smaller animals, but especially in a certain insect which has each eye covered by a rather thick membrane, that is nevertheless perforated with seven holes like the iron visor of a warrior, thus affording a passage to the images of visible things." †

At this earliest period a usual object of microscopic research was some minute insect, often a flea or a fly (hence the names "*Vitrea pulicaria*" and "*Vitrea muscaria*," as applied to Microscopes), and not infrequently the mites of cheese or of lard or vinegar-eels. In that useful treasury of the opinions of the day, the copious collection of the letters of Peiresc, we read in a document addressed to Girolamo Aleandro, dated from Paris, June 7th, 1622, of a "*Telescope* or *occhiale* of new invention, different from that of Galileo, which shows a flea as large as one of those wingless locusts called crickets, and almost of the same shape. It had two (larger) limbs and the other legs smaller. The head and almost all the rest of the body was covered and armed with crusts or scales like locusts or small shrimps. The animalcules customarily generated in cheese, called by us *Mitte*, *Mittoni*, or *Artiggioni*, and which are so tiny that they appear almost like dust, become, when seen by that instrument, as large as flies without wings. They are so distinctly discernable that they may be recognized to have very long legs, a pointed head, and every part of the body quite distinct, making us admire in the highest degree the effects of divine providence, which was far more incomprehensible to us when that aid to our eyes was wanting." ‡

* M. H. F. Fuerstenberg, "Die Krätzmilben der Menschen und Thiere," Leipzig, 1861.

† John Wodderborn, Scotobritannus, "Quatuor problematum quae Martinus Horky contra Nuntium Sidereum de quatuor planetis novis disputanda proposuit confutatio," Padua, 1610, p. 7.

‡ The vast Peiresc literature contains numerous references to the Microscope and its wonders, but few definite observations. The one quoted is reproduced from a manuscript in the Barberini Library by Professor Govi, in his "Il Microscopio composto inventato da Galileo," published in the "Atti della R. Accademia delle scienze fis. e mat. in Napoli," ii. 2a Serie, No. 1, 1888.

Of all the scientific movements that sprang to birth during the seventeenth century, none promised more fairly nor drew together more talent than the ephemeral association that, under the title of the "Accademia dei Lincei" (1603–1630), gathered round the brilliant and short-lived Federigo Cesi, Duke of Aquasparta (1585–1630) (fig. 43). The small company was accustomed to

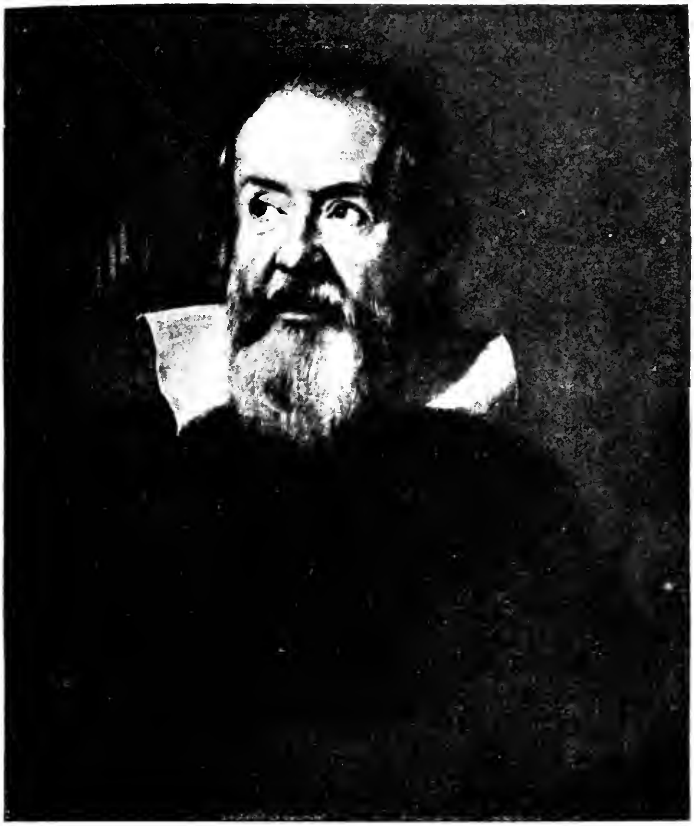


Fig. 42.—Galileo Galilei. From the portrait by Sustermans in the Uffizi Gallery.

meet at the house of the president and founder, and included several of the earliest microscopists. Besides Cesi himself and Galileo Galileo, the effective inventor of the instrument, there was Giambattista della Porta, the doyen of the group, who had given perhaps the earliest hint of the possibility of combining lenses; Fabio Colonna, the careful botanist; Francesco Stelluti, scholar and naturalist; Joannes Faber of Bamberg, resident in

Rome as physician to Pope Urban VIII; and the astronomer Francisco Fontana of Naples.

The earliest microscopical work of the "Lincei" is, unfortunately, for the most part inaccessible. It is either lost or it lies, perhaps, still at Rome, in the form of manuscript or of unissued work. Joannes Faber has happily left us a sketch of one of Cesi's botanical researches that establishes the latter as the discoverer of the spores of ferns. Faber, in a work published in 1628, after having explained that he himself had invented the word *Microscope*, tells us how "our prince Cesi commissioned an artist, specially

Fig. 43. Federigo Cesi, Duke of Aquasparta, Founder and President of the Academy of the Lynx, and the Father of Microscopy. From a medal figured by Baldassare Odescalchi in his "Memorie Istorico Critiche dell'Accademia dei Lincei," Rome, 1806.

chosen for the work, to make draughts for him of numerous plants hitherto regarded by botanists as seedless, but clearly revealed by this instrument, the Microscope, to be teeming with seeds. Such is the wonderful and minutely fine dust adherent to the back of Polypodium leaves, and appearing as big as peppercorns, but till then reckoned as Nature's mere ornament. These very objects indeed, the Prince, even before using the Microscope, had already designated as seeds, and on that account had set down the plants in the class of 'Tergifoetae.' And when in due course his books and studies of plants shall see the light, we shall possess numberless other novel observations of the Prince."

"With this Microscope also, Francesco Stelluti, the companion of the Lynx, has marvellously set forth for us the external anatomy of the bee. And he has lately caused to be engraved on copper the eyes, tongue, antennæ, head, legs, digits, and other parts of this little animal. All this, however, I had rather that you should see with your own eyes than learn from my poor pen."*

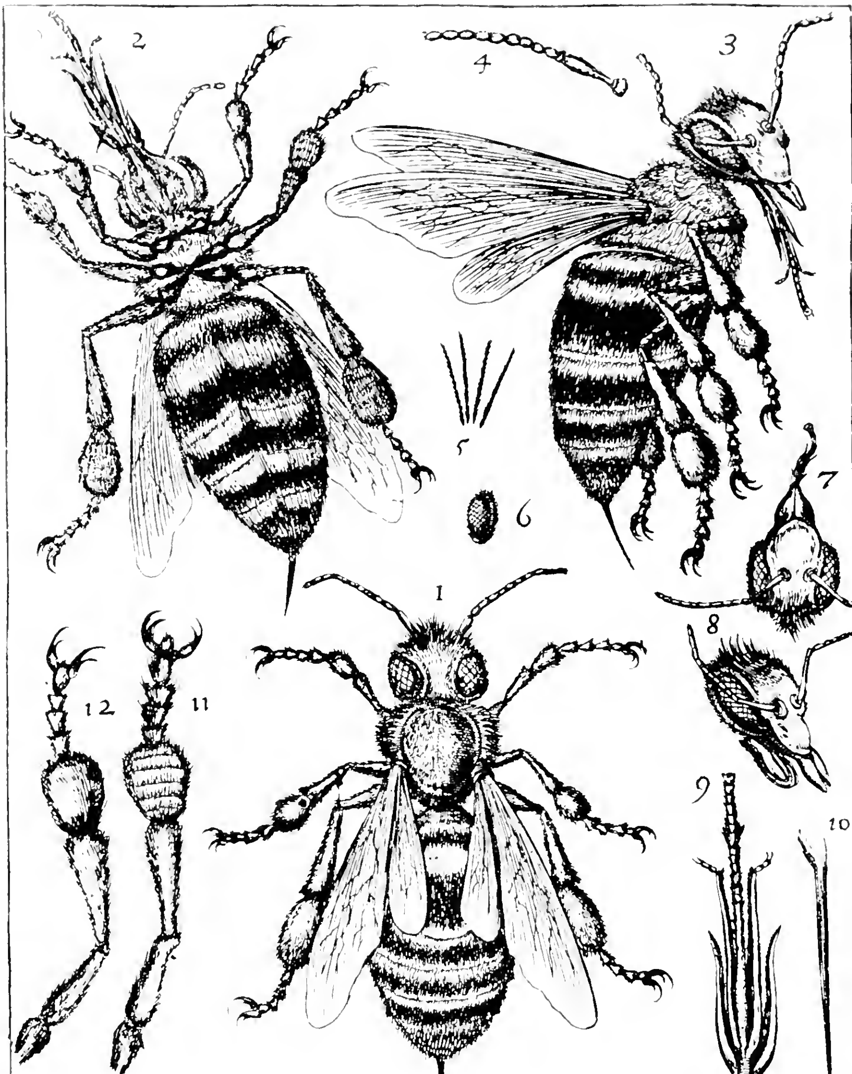
Of this work of the "Lincei" on bees we have a better record, since the drawings themselves have happily come down to us. They are of special interest as the first published figures for which the compound Microscope was used (fig. 44). "Signor the Prince Cesi," writes Stelluti in 1630, "has discoursed of these animals [bees] with the greatest erudition, ingenuity and originality, condensing volumes into a single page. On that account I also have used the Microscope to examine bees and all their parts, whose form, since they are worthy of the attention of all, I have here rendered. I have also figured separately all those members discovered by me with the aid of the Microscope, to my no less joy than marvel, since they are unknown to Aristotle and to every other philosopher and naturalist. For greater clearness, moreover, I enumerate, part by part, each of the members as verified by our Signor Fabio Colonna, a companion of the Lynx, who on my suggestion made the same investigation on this wonderful little animal with all skill and diligence. That which Signor Fabio examined and interpreted was then drawn by Signor Francesco Fontana. And then I on my part caused to be engraved here in Rome, in compliment to our noble lord Pope Urban VIII, three large bees, drawn in such detailed form as was revealed by the glasses of that Microscope. And I had them figured from three aspects, front, back, and side, as may be seen in the adjoining page." † We reproduce to their original scale these most beautiful insect drawings, which stand unrivalled in accuracy of detail for a couple of generations until the appearance of the work of Leeuwenhoeck and Swammerdam (fig. 44).

Urban VIII was a member of the family of Barberini, whose crest was a group of bees. The enthusiasm professed here, as in most of the publications of the Lincei, for this pontiff, the condemner of Galileo, was prompted, we may suspect, rather from the head than from the heart.

Federigo Cesi and his associates thus completed, before his early death in 1630, at least two important and accurate pieces of microscopic research. If, therefore, any one man can be regarded

* Joannes Faber of Bamberg, "Animalia Mexicana Descriptionibus scholusque exposita," Rome, 1628, p. 757. The work was issued separately as part of a much larger work, with which it was duly incorporated in subsequent issues dated 1649 and 1651. The passage quoted proves that the drawings of the bee, which were not published till 1630, had been completed by 1628.

† Stelluti, "Persio tradotto," Rome, 1630, p. 47.



1 Ape in atto di caminare.	7 Testa cō tutte le sue parti.	10. Aculeo, ouero Spina
2 Ape supino	8. Testa con la lingua ripie-	11 Gamba che mostra la
3 Ape che mostra il fianco	gata verso la gola	parte interiore.
4. Corno.	9. Lingua con le sue	12 Gamba dalla banda
5 Penne dell' Ape	4 linguette, o guaine	esteriore
6 Occhio tutto peloso	che l' abbracciano	

FIG. 44.—Enlarged figures of the bee, from Francesco Stelluti's "Persio tradotto," Rome, 1630. This plate, based on the work of Cesi, drawn by Fontana, and containing observations by Faber and Stelluti, is probably the earliest published drawing made by means of the compound Microscope which has come down to us. Cesi's own figures have probably disappeared.

as the father of microscopy, it is for him that the title should surely be reserved.

One of the best and most accurate early pieces of microscopic research was published in 1644 at Palermo by the Sicilian Hodierna (1597–1660). This brilliant and very acute observer applied himself to the investigation of the eyes of insects, of which he claims to have minutely examined no less than thirty-four species. His description of the eye of the fly is surprisingly fresh and good (fig. 45). "A B represents the entire head of the animal cut off from the rest of the body. It may here be seen that the head is all eyes, prominent, and without lids, lashes, or brows. It is plumed with hairs like that of an ostrich, and has two little pear-shaped bodies hanging from the middle of the forehead. The proboscis, which arises from the snout, can be extended freely and stretched forth to suck up humours, and can afterwards be directed

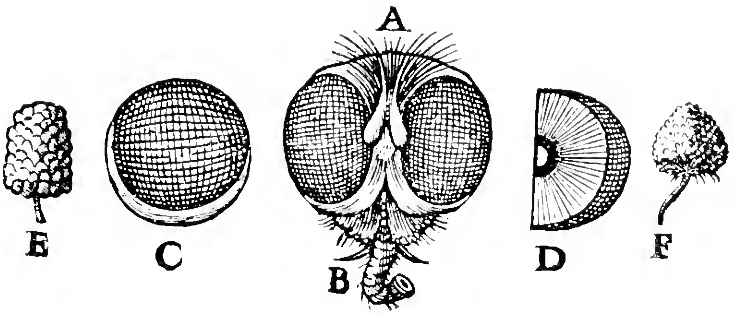


FIG. 45.—The Fly's Eye, from Hodierna, 1644.

back through the mouth to be taken into the gullet. This instrument Nature has given the creature according to its need, for it is without a neck and cannot stretch forth its head to obtain its food, as is also the case with the elephant. C represents the whole eye cut off from the head A B, on which can be seen more than thirty thousand little figures (quadretti) imprinted on the surface of the red cornea. D represents half an eye cut from the surface to the centre, so that the disposition of the crystalline structures can be seen. The crystalline structures, with their bases on the surface of the cornea, pass in a pyramidal fashion to end on the little tunic of the Uvea. This occupies the centre of the eye, and in its interior the cerebral substance is enclosed. E is a white mulberry fruit which resembles the fly's eye in its similar disposition of facets, as does also the strawberry represented at F." *

One of the very first to collect observations made by the aid of the compound Microscope was the Neapolitan Francisco Fontana

* Gianbattista Hodierna, "'L'occhio della mosca discorso fisico intorno all'anatomia dell'occhio in tutti gl'animali annulosi, detti insetti.' Palermo, 1644

(1580-1656), who was among the pioneer constructors of the instrument.* His tractate, "New observations of the things of heaven and of earth" (1646), contains a terminal chapter of four pages in which is briefly set forth a small series of observations on the mites in cheese, on the structure of the flea, the ant and the fly, and on other subjects, including the human body. We give here an example of his observations, "On the creatures that arise in powdery cheese." "The powder examined by means of this

FIG. 46.—Francisco Fontana, the Neapolitan Astronomer. From his "Novae Coelestium Terrestrumque Rerum Observationes" of 1646.

instrument does not present the aspect of dust, but teems with animalcula. . . . It can be seen that these creatures have claws and talons and are furnished with eyes. The whole surface of their body is beautifully and distinctly coloured in such sort as I have never before seen, and which, indeed, cannot be seen without wonder. They may be observed to crawl, eat and move, and are equal in apparent size to a man's nail. Moreover, their backs are all spiny and pricked out with various star-like markings and

* The very early date, however, which he claims for himself as inventor of the instrument (1618) will hardly bear critical examination.

surrounded by a rampart of hairs, all of such a marvellous kind that you would say they are a work of art rather than of nature." *

In the year 1652 a few random microscopic observations were recorded by the Italian physician Panarola,† but probably the first practical physician who used a Microscope in the course of his profession was the Frenchman Pierre Borel (1620–71). This versatile and gifted man had considerable grasp of mathematical

Fig. 47.—Title-page of Fontana's work of 1646 containing the tractate on the Microscope.

principles, and was certainly in possession of a Microscope and understood its uses before 1649.‡ His "Historiarum et Observa-

* Francisco Fontana, "Novae Coelestium Terrestriumque Observationes," Naples, 1646, Cap. III., Obs. 1, p. 148.

† Domenico Panarola, "Iatrologismorum seu medicinalium Observationum Pentecostæ quinque," Rome, 1652. See especially Observations 34, 35, and 36.

‡ In a small volume entitled "Les Antiquités, Raretés, Plantes Mineraux et autres choses considerables de la Ville, and Comté de Castres d'Albigeois," Castres, 1649, is an appendix consisting of a catalogue of Borel's museum. Among the objects mentioned are mirrors concave and convex, burning glasses, and also "De lunettes a la puce, ou microscopes qui grossissent fort les objets. De lunettes de multiplication, et pour approcher les objets," p. 147. Hoefer's "Nouvelle Biographie Universelle" refers to an earlier edition of this catalogue, dated 1645 (when Borel was only 25), which we have not seen.

tionum Medicophysicarum" of 1653 is, we believe, the first medical work involving the use of the Microscope,* and the following quotation suggests that he had already, at that early date, obtained a view of the blood-corpuscles.

"On whale-shaped Insects in Human Blood (Century III, Observation 4): Animals of the shape of whales or dolphins swim in the human blood as in a red ocean . . . . These creatures, it may be supposed (since they themselves lack feet), were formed for the bodily use of the more perfect animals within which they are themselves contained, and that they should consume the depraved elements of the blood.† If you would see them, take a sheep or ox liver, cut it in small portions and place it in water, teasing and separating it with your hands, and you will see many such animals escaping from them, nor will they be destitute of movement if the liver is fresh. They lurk in the large veins, and I think that they are those worms which are found in the stomach, being transformed when they change their position."

In 1655 Borel issued a work on the telescope with which is bound up a series of one hundred microscopic observations, mainly on minute insects, with a few crude illustrations.‡ The separate issue of these microscopic observations a few months later constitutes the first book devoted to microscopy. Borel is one of the best authorities for the early history of Microscopes and Microscopy, and a general summary of his more striking observations may not be out of place here.

1. Acari were examined and found to be hairy bear-like creatures, in which our author claimed to distinguish legs and eyes as well as various internal organs.

2. Vinegar had long been known to contain at times minute worms or "serpentes." He investigated these Nematodes and remarked on their movements.

3. Borel examined the hairs of bees and of other insects as well as of man, and vegetable fibres. All were found to be not solid but hollow.

4. Minute insects found floating in the air were closely observed

* Pierre Borel, "Historiarum et Observationum Medicophysicarum Centuria, prima (et secunda)," Castres, 1653. Our authority for the existence of this edition, which we have not seen, is Hoefer's "Nouvelle Biographie Universelle." We have ourselves used and quoted the Paris edition of 1656. There were several subsequent editions.

† The language of Borel at this point is not very clear, and it is possible that he had been examining small clots rather than blood-corpuscles. We incline, however, to the belief that it was the corpuscles themselves that he had seen. In any event, he has an unequivocal passage on the subject in his volume of microscopical observations.

‡ Pierre Borel, "De vero Telescopii Inventore cum brevi omnium conspicillorum historia. . . Accessit etiam Centuria Observationum Microscopicarum," The Hague, 1655. The separate title-page of the microscopic observations bears the date 1656

and even figured. He suggested that some of these were the cause of plague, a doctrine which became popular at the time, and was developed by Athanasius Kircher.

5. He made a special study of certain small spiders, examining and carefully enumerating the number and distribution of their eyes, which were shown to vary in different species. The crystalline structure of the eyes was distinguished. In some spiders, as well as in lice, Borel thought he could see the contractile motion of the heart.

6. Ants were examined and found to be possessed of eyes derived from those in the larvae, and the larval nature of the so-called ant's-eggs was demonstrated. The eyes of flies were found to have many facets, the number being estimated at 300. He clearly saw the terminal claws of the fly's leg, and likened them to those of a lion.

7. Silkworms were shown to secrete their silk not from the mouth, as had been previously supposed, but from little teat-like processes, the thread subsequently passing through and being guided by the jaws.

8. Some of Borel's most remarkable observations were made on plant anatomy, and have been unaccountably passed over. He saw minute markings on young leaves which were probably outlines of cells, and he has one passage that apparently describes the movement of protoplasm, an observation which preceded that of Corti on Chara by more than 100 years. He appears to have seen the stomata on leaves, and to have fully realized their power of opening and closing. He followed up Cesi's observations on the fronds of fern and saw the spores.

9. The first microscopical observation of medical value was made by Borel. He succeeded in making out ingrowing eyelashes which were invisible to the naked eye, and whose removal relieved conjunctivitis. He prophesied the general use of the Microscope in medicine.

10. He made a number of observations which, while not in themselves completely accurate, preceded the more striking and epoch-making observations of the great classical microscopists. Thus he saw the oil globules of milk, and noted that they were more distinct when the milk was sour. He was probably the first to apply the Microscope to the early stages of the development of the chick, in whose embryo he was able to see parts invisible to the naked eye. He distinguished the separate teeth and beautiful pattern in the radula of a slug, and in the "horns" of the same animal he saw the eyes. It has already been explained that he probably was the first to see the blood corpuscles. In an observation on the blood of fever patients he suggests that these corpuscles are little worms and the cause of the fever. He saw similar corpuscles in the serum exuded from wounds and in the discharges of

ulcers. It seems, moreover, highly probable that he caught a glimpse of infusoria and possibly of bacteria, for he assures us that all decomposing material swarms with similar worms. Further, he gives us perhaps the first hint of tissue structure. "The heart, kidneys, testicles, liver, lungs, and other parenchymatous organs," he says, "you will find to be full of little structures (organula) and they are like sieves by means of which nature arranges the various substances according to the shape of the holes. Passage is thus given only to atoms of a certain shape."*

With all these observations to his credit, and considering the very early date at which they were made, it seems but right that the name of Pierre Borel should be rescued from the oblivion in which it has long lain, overshadowed by his great successors of the classical period. Cesi and Borel may indeed be regarded as the founders of microscopical observation.

We may conclude our sketch of the pioneer microscopists with a consideration of the work of the German Jesuit, Athanasius Kircher (1601–1680), who by long domicile in Rome came deeply under the influence of Italian science.

Kircher was a very voluminous and wordy writer, the successive appearance of whose numerous works was awaited by the learned and curious with an eagerness that it is now difficult to understand. In most of his works he is quite uncritical and lacking in judgment, though he displays some originality, combined with a remarkable power of absorbing both information and misinformation. In his book on the Plague, however, published in 1658,† he shows genuine insight, and gains a clear though distorted view of organisms of minute size acting as the vehicles of contagion. Being himself a practical microscopist, Kircher was aware of some of the difficulties and possibilities of the method. Thus, although his work is characterized by total disregard of "control" observations, and is undeniably marred by his mediæval credulity, he yet shows a first-hand acquaintance with minute life, which proves that he had himself endeavoured to explore the microscopic world and had perhaps seen infusoria. He develops a view of infection depending on the supposed observation of organisms in the blood of plague patients. These minute "worms" in the blood of the plague-stricken were, however, not bacteria but more probably rouleaux of red cells. Kircher's observations or "experiments," as he calls them, were undertaken with a view

* "Observationum Microscopicarum Centuria," The Hague, 1656, Obs. 76.

† "Scrutinium Physico-Medicum contagiosæ Luis, quæ Pestis dicitur, quo origo, causæ, signa, prognostica Pestis, nec non involentes malignantis Naturæ effectus, qui statis temporibus, cælestium influxuum, virtute et efficacea, tum in elementis; tum in epidemiis hominum animantiumque morbis elucescunt, una cum appropriatis remediorum Antidotis nova doctrina in lucem eruunter," Rome, 1658. Dedicated to Pope Alexander VII.

of providing evidence for his theory of the nature of plague. A few of them we give here.

"*Experiment* 1.—Take a piece of meat which you leave exposed by night until the following dawn to the lunar moisture. Then examine it carefully with the Microscope, and you will find the

FIG. 48.—The Jesuit Father Athanasius Kircher. From a plate by Bloemaert, dated Rome, 1655.

contracted putridity to have been altered by the moon into innumerable wormlets of diverse size, which, however, would escape the sharpest vision without a good Microscope . . . . The same is true of cheese, milk, vinegar, and similar bodies of a putrescible nature. The Microscope, however, must be no ordinary one, but constructed with no less skill than diligence as is mine.

which represents objects a thousand times greater than their true size.

"*Experiment II.*—If you cut up a snake into small parts and macerate it with rain-water, and then expose it for several days to the sun, and again bury it under the earth for a whole day and night, and lastly examine the parts, separated and softened by putridity, by means of a Microscope, you will find that the whole mass swarms with innumerable little multiplying serpents, so that even the sharpest eyes cannot count them.

"*Experiment III.*—Many authors claim that unwashed sage is injurious . . . but I have discovered the cause of this. For when, by means of the Microscope, I minutely examined the nature of this plant, I found the back of the leaves entirely covered by raised work, as with the figure of a spider's web, and within the web appeared infinitesimal animalcules, which moving constantly came out of little buds or eggs. . . .

"*Experiment IV.*—If you examine a particle of rotten wood under the Microscope, you will see an immense progeny of tiny worms, some with horns, some with wings, others with many feet. They have little black dots of eyes. . . . What must their little livers and stomachs, their tendons and nerves be like?"

With Kircher we leave the first or pioneer period of microscopical discovery and enter on the classical epoch. About this time fused glass threads began to be used as magnifiers, while the manufacture of small lenses of short focal length was greatly improved by Eustachio Divini and others.* A new era may be said to commence with the publication in 1661 of a tract by a young Italian Professor, Marcello Malpighi (1628–1694). In that epoch-marking work is described for the first time the capillary circulation of the blood, the object chosen for investigation being the surface of the frog's lung.† The entrance of Malpighi introduces a new period in the history of our subject, for guidance in which we may leave our readers to other hands.‡

* See Carlo Antonio Manzini's "L'occhiale all'occhio, Dioptrica pratica," Bologna, 1660.

† Marcello Malpighi, "De pulmonibus observationes anatomicae," Fol., Bologna 1661. The original tract is excessively rare, but has been frequently reprinted in the various collected editions of Malpighi's works.

‡ Notably, Professor L. C. Miall's admirable volume on "The Early Naturalists, their Lives and Work (1530–1789)," London, 1912.

SUMMARY OF CURRENT RESEARCHES

RELATING TO

ZOOLOGY AND BOTANY

(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),

MICROSCOPY, ETC.*

ZOOLOGY.

VERTEBRATA.

a. Embryology.†

Cluster Formation of Spermatozoa.‡—Jacques Loeb finds that when the spermatozoa of a sea-urchin are placed in sea water which has been standing above eggs of the same species they form temporary clusters. The cluster formation resembles the phenomena of surface tension in varying respects, e.g. the clusters tend to be spherical, and two clusters fuse into a larger one. When sperm is put into ordinary sea water or into the supernatant water of foreign eggs these apparent surface-tension phenomena are not observed. In real sperm agglutination neither cluster formations nor the above-mentioned surface-tension phenomena are noticeable.

It was found that the cluster formation is a direct function of the motility of the spermatozoa. As soon as the spermatozoa are immobilized by NaCN, or by a high temperature, or by KCl, the cluster formation ceases. When the motility returns the cluster formation occurs again. The real agglutination of sperm occurs just as well when the sperm is immobilized as when it is motile.

The clusters last only a few minutes, like Lillie's sperm "agglutinations." They last longer in a neutral than in an alkaline solution. Loeb suggests that the phenomenon is essentially or partly due to a negative chemotropism of the spermatozoa to the egg water. Eggs which have been treated with acid sea water lose permanently their power of producing a substance which causes the cluster formation of

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, etc., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so-called, but also those dealing with Evolution, Development, Reproduction, and allied subjects.

‡ Journ. Exper. Zool., xvii (1914) pp. 123–40.

the spermatozoa of their own species: while the acid sea water in which the eggs were treated will, when filtered and neutralized with NaOH, induce a very powerful cluster formation. If it is true that the acid dissolves the chorion or jelly-like substance surrounding the egg, the experiment would prove that the substance which causes the cluster formation is not formed in the egg but in the chorion. If this substance is identical with the substance which Lillie calls "fertilizin," his theory concerning the rôle of this substance encounters serious difficulties.

Eggs which have been treated with a mineral acid like HCl, and have permanently lost the power of causing a cluster formation of the spermatozoa, can nevertheless be fertilized normally with sperm of the same species. When the acid used was a fatty acid, and when membrane formation occurred, the eggs also lost permanently their power of inducing cluster formation, but retained their power of being fertilized by sperm, provided that the membrane was first torn. The supernatant sea water of the eggs of *Strongylocentrotus franciscanus* will not induce cluster formation of the sperm of *S. purpuratus*, yet the sperm of the latter will fertilize the eggs of the former. The sperm of *Asterias ochracea* undergoes no cluster formation in the supernatant sea water of *S. purpuratus*, no matter whether the sea water is normal or hyper-alkaline, but the starfish sperm readily fertilizes most or all of the eggs of *S. purpuratus* in hyperalkaline sea water. Loeb concludes that the facts mentioned in this paragraph prove that the substance which is responsible for the cluster formation is not necessary for the process of fertilization.

Germ Cells and Somatic Cells.*—Leo Loeb discusses the relation between germ cells and somatic cells in the light of some results of experimental pathology.

1. Investigation of tumour growths (cancer) has brought to light facts which are against the conception of a radical difference between germ cells and somatic cells, as far as potential immortality is concerned. As is most clearly seen in superficial cancers, the cancer cells are undoubtedly the offspring of ordinary somatic cells. In the case of teratomata, the origin is probably from parthenogenetically developing ova in the gonads or elsewhere, but the tumour cells are no longer germ cells, but somatic cells. Now, one of the most characteristic properties of cancer cells is that some kinds can grow after transplantation into other animals of the same species. (Others are too sensitive apparently to the chemical composition of the body fluids to survive transplanting.) In each animal there are many successive generations of tumour cells, and after transplantation each surviving cancer cell produces again new generations. The potential proliferative capacity of the cancer cells is enormous, and there is a great potential duration of life. An epithelial tumour found by Jensen in a mouse has been propagated for almost fifteen years. This suggests a potential immortality such as germ cells and Protozoa have. Minot suggested that cytomorphosis (relative increase in size and differentiation) implied death of somatic cells, but

* Amer. Naturalist, xlix. (1915) pp. 286–305.

this may be in part the result of unfavourable environmental conditions for the cells. Thus, tumour cells degenerate and die when relatively far from the blood-vessels. The fitness of a tissue to grow depends on the specific adaptation between the tissue and the body fluids, and on the way in which various substances are carried to the tissue. The success of transplanted tissue depends on similar conditions. The power of living on is much greater than the power of growing. While the differentiation of such cells as ganglion cells may entail the loss of the power to propagate, and may also entail greater sensitiveness to stimuli, it does not necessarily mean that the cells in question must die. The problem of the prolongation of life may to a great extent depend on the possibility of preventing injurious influences which at present disturb the function of ganglion cells from attacking these cells and causing their death.

2. The germ cells are potentially immortal, but this cannot be realized without the nuclear changes involved in maturation, followed by fertilization or parthenogenetic development. Similarly, Woodruff and Erdmann have emphasized the importance of endomixis in the generations of *Paramecium*, which also show potential immortality. Of such rearrangements in somatic cells or in tumour cells there is no evidence, nor of any rhythmic occurrence of vigour and depression.

3. Poisons acting on an organism may affect the germ cells, and thus the following generations. Lesions recur, but not always the same lesions. In a similar way in the case of somatic (tumour) cells, characters acquired under the influence of external agencies may be transmitted to the succeeding cell generations. It can be shown in the case of the somatic cells that apparently similar changes produced through different external agencies are really not identical, but specific. It is suggested that such a specificity of transmitted characters may also exist in the case of germ cells, despite the apparent identity of changes produced through different external agencies. Loeb reports on a case in which a change in somatic cells was transferable to the following cell generations. It was of such a nature that it would be pronounced non-specific, if ordinary criteria are used. But by the use of special methods the change was shown to possess a definite characteristic relationship to the external factor that caused it, and must therefore be called specific. In germ cells there may also exist a difference in the mode of production of lesions through the action of different substances, and consequently aspecificity in the acquired lesion, notwithstanding the apparently unspecific character of the lesion.

Development of Nerve Cells of the Chick.*—E. V. Cowdry has studied the development of the cytoplasmic constituents of the nerve cells of the chick, with particular reference to mitochondria and neurofibrils. The neurofibrils are first formed in developing chick embryos as a differentiation of the ground substance (in the majority of cases of the peripheral neuroblasts), at a stage of fifteen somites, 5·8 mm. in length, after forty hours' incubation at 39° C. The earliest neurofibrils

* Amer. Journ. Anat., xv. (1914) pp. 389–428 (5 pls.).

are found in the hind-brain opposite the otic invaginations, in the nuclei and root fibres of the cranial nerves, and in a centre on either side of the extreme anterior end of the mid-brain.

There is no evidence that mitochondria are transformed into neurofibrils. The mitochondria do not decrease in amount as the neurofibrils develop, nor change in their structure or staining reactions. Mitochondria are present in the early stages in the differentiation of the nerve cells of the chick, and there is ample evidence that they occur throughout cytomorphosis. The neurofibrils, on the other hand, are only present from the fifteen-somite stage onwards, in evident adaptation to functional demands. Mitochondria may therefore be regarded as cytoplasmic elements of a generalized nature, not participating in so specialized a cell function as the development of neurofibrils: while the neurofibrils are to be looked upon as indicative of the differentiation of the cells in which they are found.

Development of Rectal Gland of Squalus acanthias.*—E. R. Hoskins finds that the "digitiform gland" appears as a slight thickening of the endoderm of the dorso-lateral border of the gut just posterior to the spiral valve. The thickening soon pushes out laterally to form a hollow bud which turns and grows anteriorly along the gut. From the main part of the gland small buds resembling the original form of the gland grow laterally on all sides; they become tubules which give rise to secondary tubules; the gland becomes a compound tubular structure. As the gland develops it carries the mesentery of the intestine with it, and is thus supported from the dorsal wall of the body cavity. The endoderm is at first four layers thick: it is gradually reduced to a single-layered epithelium from which the primary and secondary tubules grow out. The epithelium lining the main or central lumen subsequently thickens, resulting in a structure of two layers of columnar cells with rounded nuclei in the embryo before birth, and of four layers in the adult fish.

Development of Lungs of Alligator.†—A. M. Reese finds that the primordia of the lungs in the alligator are budded off from the ventral side of the pharynx, just behind the region of the gill clefts. They are first seen in embryos of about thirty somites. A description is given of the appearance and minute structure of successive stages, and there are many illustrations.

Reaction of Embryonic Cells to Solid Structures.‡—Ross G. Harrison has tested the hypothesis that embryonic cells moving in clotted lymph are positively stereotropic. The plan of experimentation consisted in varying the three main factors involved in the cultivation of tissues, viz. the tissue itself, the fluid medium, and the solid support.

* Proc. Amer. Assoc. Anatomists, 31st Session, in Anat. Record, ix. (1915) pp. 83–4.

† Smithsonian Misc. Coll., lxv. (1915) pp. 1–11 (9 pls.).

‡ Journ. Exper. Zool., xvii. (1914) pp. 521–44 (14 figs.).

All these factors have some determining relation to the movements of the cells. Tissues were taken from the embryos of *Rana palustris* just after the closure of the medullary folds and from chick embryos. The fluid media used were physiological sodium chloride, Locke's and Ringer's solutions in varying degrees of concentration, the blood plasma of the frog, and the serum of the chicken. The means used to support the planted tissue were the fibrin network of the clotted plasma, spider web, and the surface of the cover-glass. The use of pieces of spider web proved a very effective innovation.

The experiments lead to the conclusion that solid objects are an important and even necessary factor in the movement of embryonic cells, such as mesenchyme and epithelium. Leaving out the cases of movement upon the surface film, there are no exceptions to the rule that movement takes place only when contact with solid material is attained. Each of the three kinds of solid support used in the experiments influenced the cell movement in its own way.

The question arises whether these reactions are to be regarded as a manifestation of stereotropism (thigmotaxis), which is a response to mechanical stimulation (pressure), or whether the solid acts only indirectly by inducing conditions that give rise to chemical or some other form of stimulation. Burrows has shown that the centrifugal movement of cells observed in almost all cultures, i.e. the movement from the implanted cell mass out into the culture medium, may be explained by the acidity produced in the main mass of cells through the accumulation of waste products. Pseudopodia will be formed on the side away from the acidity. But Harrison points out that the chemical stimuli are powerless to call forth the movements in the absence of solid support. Moreover, the acidity theory offers no adequate explanation of the adaptation of single cells to such minute structures as the web fibres, nor of the fact that outwandering cells rapidly bridge a gap between two separate pieces of tissue in the same culture. The facts show that the cells are stimulated by solids as such, and respond to them by an orienting movement. Harrison finds no reason for refusing to call the reaction to solids a tropism.

It may be that stereotropism may have something to do with the phenomena of normal development, e.g. of the sheath cells of an embryonic nerve. Similarly, the close application of mesenchyme cells to such structures as blood vessels, muscles, and various other organs, resulting in the formation of a cellular sheath, which afterwards becomes sclerotized, may be due in the first instance to a stereotropic response. The surface of structures such as the medullary cord, notochord, alimentary canal, muscle-plates and the inner surface of the epidermis would serve as a solid base upon which cells may creep. In the encystment of foreign bodies within an organism a similar phenomenon is observed.

With regard to the movements of the growing nerve fibre, the evidence points again to the conclusion that the protoplasm is stereotropic. No free outgrowth of nerves in a fluid medium has ever been observed, But such solids as a fibrin clot or a smooth glass surface readily serve to support them. And so may the surfaces of the larger cell masses and

the interstitial protoplasmic network inside the embryo. This line of investigation is obviously of great importance, for as we come to know the properties of individual cells in detail, it will be possible to form an accurate conception of the influences actually at work in shaping the embryonic body.

Lymph Hearts of Chick Embryos.*—Eleanor Linton Clark and Eliot R. Clark have studied the pulsations of the posterior lymph hearts in chick embryos and their relation to the body movements. The pulsation first appears in embryos of six to seven days (19–22 m.m.), and at this earliest stage is intimately connected with the periodic movements of the embryo. Lymph heart contractions accompany the periodic spasms and never occur in the interval between body movements. Each beat is invariably accompanied by a contraction of the tail. When the body movements are paralyzed by chloretone, the lymph heart pulsations also cease.

In successive later stages there is a gradual increase in the independence of the beating lymph heart. First, the pulsations become dissociated from the tail contraction, although still occurring only during the periods of body movements. Then there is a series of stages in which the lymph heart contracts more and more frequently during the period of rest, although still beating a number of times during each spasm. When chloretone is added, at these stages, a larger number of single pulsations occur independently, at irregular intervals. At these stages, the lymph heart is capable of entirely independent function, but is influenced in its rhythm by the periodic spasms of body movements.

Finally, a stage is reached in which the lymph hearts are uninfluenced, in any way, by the body movements. During all of these stages, mechanical stimuli, such as pressure over the surface with a fine needle, or direct puncture of the myotomes, failed to influence the body movements. Although the lymph heart does not respond to pressure over the surface, it always contracts when its wall is actually pierced. At the stage in which the lymph heart is not yet independent, such a puncture instigates tail contractions along with the lymph heart pulsations, while at later stages it stimulates the lymph heart alone.

The authors were unable to come to a decision in regard to the structural connexion between the lymph heart and the body musculature. They suggest four possibilities and discuss them :—(1) that the lymph heart musculature is derived from the myotomes, and that there is for a time a connexion between the two ; (2) that the muscle of the lymph heart is temporarily supplied by the same nerves which supply the myotomes ; (3) that the lymph heart is merely stimulated mechanically by the contraction of the adjacent muscles ; and (4) that, at first, the contractions of the lymph heart result from the same stimulus which brings about the periodic body movements, and that this stimulus is gradually subordinated to the stimulus caused by the increasing amount of lymph, brought to the lymph heart by the lymphatic vessels from the fast-growing allantois and from the posterior half of the chick.

* Journ. Exper. Zool., xvii. (1914) pp. 373–94 (2 charts).

Feeding Experiments on Tadpoles.*—J. F. Gudernatsch finds that there is a certain constant minimum size which tadpoles must reach before the final metamorphosis can begin. There is, on the other hand, a constant assimilation of food and a gradual increase in body size up to a constant maximum, beyond which a normal animal may not pass without the beginning of the final differentiation and metamorphosis.

In thyroid-fed tadpoles there is differentiation without growth. In thymus-fed (and spleen-fed) tadpoles there is growth without differentiation. There are thus two distinct factors—the factor of growth and the factor of differentiation. The two naturally work simultaneously, but differentiation is not the result of growth, nor is growth necessarily followed by differentiation. The thyroid must possess a capacity for stimulating differentiation which other foods do not possess; the thymus (or spleen) has a quality that suppresses differentiation. Thus, the thyroid and thymus must produce, or at least contain, agents which, when passed into developing organs, in the one case stimulate, in the other suppress, differentiation. The production of such substances to be thrown into the circulation characterizes the thyroid and thymus as glands with a positive internal secretion.

Weight of Thymus in Rat according to Age.†—Shinkishi Hatai finds that the thymus in the albino rat (*Mus norvegicus*) shows great variability in weight. The variability is greatest at the period of rapid growth of the body, and becomes less as the growth of the body is slowed. The greater variability during the first six weeks may be attributed to the greater variability of the body weight, for the weight of the thymus at this period varies not only with age, but also with the body weight, while in the older rats this is not the case.

Interstitial Cells of Mammalian Ovary.‡—B. F. Kingsbury has studied these elements in the cat. They are modified stroma cells, and hence of connective tissue origin. Their origin in the adult as an hypertrophy of theca cells during atresia folliculi is confirmed. In the fœtus and in the new-born, and immature kitten, they appear associated with the irregular so-called medullary cords and follicle formations of these periods. Free lipoid cells appear in the indifferent cells of the atretic follicles, medullary cords and irregular medullary formations in parts not associated with the ova. The development of interstitial cells appears to be correlated with the activity of the indifferent or follicle cells in the absence of germ-cells. The suggestion is strong that an element of degeneration is involved. The zone in which interstitial cells occur conforms to the centrifugal march of differential growth in the ovary. No morphological value is attached to the distinction between a fœtal (or presexual) and an adult grouping of the cells. No evidence is found for regarding the interstitial cells as constituting morphologically an intra-ovarian gland. The recognition of them as a gland of ovarian secretion is regarded as without sufficient evidence.

* Amer. Journ. Anat., xv. (1914) pp. 431–78 (2 pls.).
† Amer. Journ. Anat., xvi. (1914) pp. 251–7 (1 chart).
‡ Amer. Journ. Anat., xvi. (1914) pp. 59–95 (3 pls.).

It is suggested that the conditions determining the appearance of interstitial cells in the ovary hold also for the testis.

Sex-ensemble.*—D. Berry Hart defines sex with primary reference to the nature of the sex-gland. The nature of the duct system alone or of the secondary sexual characters does not enter into the strict definition. A typical sex-ensemble includes a normal sex-gland, a developed duct system characteristic for the sex, an opposite sex-duct element in a degenerated condition, and a secondary sexual series of characters congruent with the sex. The normal duct system should be at a maximum, the opposite sex-duct element at a minimum. In atypical forms the normal sex-duct segments are diminished in number, the opposite sex-duct elements increased, and the secondary sexual characters non-congruent. Any of the units of sex-ensemble may be inverted, and this is an intrinsic result. The sex-ensemble is determined by the gametic determinants. The gametes only determine the sex-duct element. It is the primitive germ- or sperm-cells, formed shortly after the zygote arises, that, travelling through the germ-layers and entering the sex-gland, give rise to sex. The nature of the germ-cells in the sex-gland, and that of the potent, non-potent, and congruent secondary sexual characters gives the sex-ensemble. Intrinsic changes in the germ-plasm give rise to variations, and mutations, in particular, are to be associated with loss of polar bodies, maturation, and the formation of gametes. It is suggested that the determinant of the evolutionist becomes more intelligible when conceived of as comparable in behaviour to the atom of the physicist.

b. Histology.

Epidermis of Amphibians Cultivated Outside the City.†—S. J. Holmes continues his investigations on pieces of tissue cultivated in lymph and plasma.‡ His observations on the movements of isolated melanophores have been recently summarized.§ Most of his recent experiments relate to the epidermis of the larvæ of *Diemyctylus torosus*, and the pieces were cultivated in lymph or plasma.

The epidermis of amphibian larvæ grows well in a mixture of equal parts of a 2 p.c. gelatin solution and blood serum from the adult animal. Epidermis shows a marked thigmotaxis, and in hanging drop cultures extends away from the implanted tissue along the lower side of the cover slip and the lower surface of the drop of culture medium. The extending mass of epithelium usually takes the form of a broad, thin sheet, whose outer border is formed of very thin clear protoplasm furnished with fine pseudopodia.

Sheets of extending epidermis are sensitive to slight stimulations, and show a remarkable degree of contractility, often drawing in to a small fraction of their previous superficial area. Strong contractions of

* Edinburgh Med. Journ. (June, 1915) pp. 1–21.
† Journ. Exper. Zool., xvii. (1914) pp. 281–94 (1 pl.).
‡ See this Journal, 1914, p. 245.
§ See this Journal, 1915, p. 133.

epidermis are evoked by thermal, chemical, osmotic or contact stimuli, but strong light has no appreciable influence on the epithelial cells. After contraction the epithelial mass may spread out as widely as before.

Epidermis from amphibian larvæ may be kept alive for several months if it is transferred occasionally into fresh culture medium. Mitotic cell divisions were observed in the living cells fifty days after implantation into the culture medium. Amitotic nuclear divisions were found, especially on preparations that were kept for several weeks without a fresh supply of nutrient fluid.

Epidermal cells from embryos of *Diemyctylus* were seen to undergo differentiation *in vitro* into the different types of cells found in the epidermis of late larval stages. Pieces of epidermis from the adult frog form extensions much like those from the larva, but growth is less rapid. The extensions of the epidermis in both larval and adult forms are due to the amœboid activity of the hyaline protoplasm along the margin of the extending mass.

Microscopical and Chemical Study of Feather Pigments in Pigeons.*—Orren Lloyd-Jones has sought by experiment to analyse the factors conditioning the various self-colours of the tumbler pigeon. The pigments concerned belong to the melanin series and are granular in nature. There is a red-brown pigment which produces the red and yellow colours in tumbler pigeons. In red birds this pigment always exists as spherical granules, which are in "typical red" about $0 \cdot 3\ \mu$ in diameter, but in "plum colour" they are $2\ \mu$ or more in diameter. In reds there is abundant pigmentation in the intermediate cells of the epidermis, independently of specialized pigment cells. In yellows the pigment is so finely divided that its granule form cannot be determined. There is a black pigment which under different conditions produces the colours black, dun, blue, and silver. In black birds this pigment may exist as spheres $0 \cdot 5\ \mu$ in diameter, or as rods $1\ \mu$ long. Some blacks show entirely one category of granule form and some entirely the other. In most blacks, however, both kinds are to be seen, although there is commonly a marked predominance of one or the other type. In blacks the pigment cells are better developed than in reds and elaborate a greater proportion of the pigment.

Pigment granules in dun birds are invariably spherical in form and about $0 \cdot 3\ \mu$ in diameter. Dun colour may be seen in birds which are not dun genetically, but differences in granule form and distribution show that this is not the character dun which behaves as a unit in inheritance.

"Blue" of pigeons is produced by the black pigment clumped and distributed in such a way as to produce the blue effect. Granules in blues are spherical, $0 \cdot 8\ \mu$ to $1\ \mu$ in diameter. The development of the pigment in blues is not so promiscuous and "disorderly" as in blacks. It is apparently controlled by an influence lacking in blacks.

After the pigment arrives in the barbules it undergoes a "clumping" process which gives it its characteristic distribution. The feathers from

* Journ. Exper. Zool., xviii. (1915) pp. 453–508 (7 pls.).

blue rumps on black birds show granules much larger than those in other blue feathers.

Pigment in silver feathers is distributed in the manner characteristic for blue. In "silvers" the barbule surface appears greatly pitted and roughened. The red and black pigments show pronounced differences in their behaviour towards reagents and solvents. The intensity factor has about the same quantitative value in blacks and reds, and results in the formation, in intense birds, of about three times the amount of pigment present in dilute birds.

Passing to consider the genetic factors, the author holds that the six fundamental self-colours of tumbler pigeons can be accounted for by the interaction of four genetic factors: R, red; B, black; I, intensity; and S, spreading. Evidence as to the nature of the factor B has been secured from its effect on the feather pigment with respect to (*a*) colour, (*b*) manner of formation and distribution, (*c*) physical form, and (*d*) chemical properties. All of these seem to indicate a different mechanism from that which produces red pigment, rather than simply a later stage of the same process.

Uninfluenced by other factors, the final result of the pigmentation process in a bird carrying B is the clumping of the pigment into the middle of the barbule cells. The factor S, when present, stops this clumping process and results in a "spread" condition of the pigment. S may properly be considered as an inhibitive or "stopping factor."

As regards the increment of pigment, the factor I has probably a constant effect when acting on dilute birds of different constitutions, namely, to increase by about three times the amount of pigment produced. As regards its influence on granule shape, on the other hand, it reacts in a different manner with each combination of factors. The facts concerning the granule shape in blacks suggest the possible existence of a factor not yet determined which is specifically concerned with granule shape.

The author remarks, in conclusion, that "genetic research which is confined only to obvious characters is often superficial, and in such cases microscopic research is necessary to distinguish the independently heritable characters involved."

Reactions of Amphibian Larvæ to Light.*—Henry Laurens finds that tadpoles of *Rana pipiens* and *R. sylvatica* show no response to the stimulus of light, while the larvæ of *Amblystoma punctatum* are positively phototactic, both when normal and when deprived of their eyes. The reactions of eyeless individuals are not brought about by the stimulation of the central nervous system, but of the nerve endings in the skin. Normal larvæ placed in light become pale, blinded larvæ dark. Normal larvæ placed in darkness become dark, blinded larvæ pale. The condition of the pigment in the skin chromatophores does not affect the sensitiveness of the larvæ to light; but previous exposure to light, or adaptation to darkness, does, in that dark-adapted larvæ are more sensitive to light than are those which have been kept in the light.

* Journ. Exper. Zool., xvi. (1914) pp. 195–210 (2 figs.).

The youngest larvæ to give responses to light of 768 candlemeters intensity were between 11 and 12 mm. long.

Amœboid Movement in Melanophores of Frog.* — Davenport Hooker has studied the melanophores in the corium of the larvæ of *Rana pipiens* and of the adults of *R. fusca* and *R. pipiens*. The pigment granules contained within the melanophores of both larvæ and adults are carried in the cell cytoplasm. They are not carried in intracellular canals, or along rod-like structures, or in a specialized kind of protoplasm. They show no definite relation to one another or to the nucleus. In both larvæ and adults the melanophores lie in preformed spaces in the connective tissue and corium respectively. Those of adult frogs fill the branches of their preformed spaces in the fully expanded phase, those of tadpoles do not. The melanophores of adult frogs have expansion-phase patterns which are constant for each cell and which are forced upon the cells by their preformed spaces. The melanophores of both larval and adult frogs expand and contract within the spaces which enclose them. As the processes of expansion and contraction are performed by means of pseudopodia, the melanophores are rightly called amœboid.

Adipose Tissue.†—Ed. Retterer has studied this in the rabbit and from the sole of the foot in man. Adipose tissue is preceded by a reticular connective tissue, the elements of which have a granular protoplasm with anastomosing meshes filled with hyaloplasm. This tissue is served by a dense network of capillaries; its chromophilous filaments multiply, and the hyaloplasm is transferred first into adipogenous granules and then into fat globules. These accumulate between the chromophilous filaments which have become partially elastic. The "adipose vesicles" are not cells, but represent internuclear areas charged with fat.

Non-medullated Nerve Fibres.‡—J. Nageotte finds that there is complete morphological correspondence between the axis cylinder of non-medullated and of medullated nerve fibres. Both contain a considerable quantity of serous material, and differ only in dimensions. A composite non-medullated fibre consists of a syncytial protoplasm interpenetrated by numerous axis-cylinders, which are disposed at equal distances and occupy parallel cylindrical compartments, bounded by plasmic partitions. The structural units are not the axis-cylinders with their plasmic surroundings, but the composite fibres themselves—all that is inside the syncytial sheath.

c. General.

Nutrition of Marine Invertebrates.§—H. Blegvad has studied in a systematic way the food and conditions of nutrition among the communities of Invertebrates found on or in the sea-bottom in Danish

* Amer. Journ. Anat., xvi. (1914) pp. 237–50 (3 figs.).
† C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 5–9.
‡ C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 12–16 (3 figs.).
§ Rep. Danish Biol. Station, xxii. (1915) pp. 43–78 (4 figs.).

waters. The food in the sea consists mainly of (1) growing plants of the benthos formation (especially *Zostera* and its attendant micro-flora), (2) detritus of dead and dying organisms and portions of organisms, and (3) animals living and dead.

Plankton is not included as a principal source of nourishment, for Blegvad maintains that the only plankton organisms which are of direct importance to the fishes and bottom fauna in the Danish waters are the pelagic Crustaceans and the pelagic larvæ of the bottom organisms themselves. Phytoplankton is of little importance save for some zooplankton organisms. The great majority of the animals composing the bottom fauna live on detritus, none on pure phytoplankton.

Pütter's theory of dissolved carbon compounds in sea-water is not corroborated. In his calculations he did not allow enough for the detritus.

Marine animals may be grouped as pure herbivores, pure carnivores, and detritus-eaters. They may be divided into those without and those with hard prehensile or masticatory organs. The former include :—1. Those feeding by pseudopodia (Foraminifera). 2. Those feeding by ciliary currents (sponges, bivalves, ascidians, lancelets). 3. Those feeding by means of arms or tentacles, frequently furnished with cilia (many Polychæts and the Holothurians). 4. Those feeding by means of a soft, generally extroversible proboscis for drawing up detritus. 5. Those feeding by means of tube-feet (Ophiuroids and Asteroids). 6. Those feeding by means of tentacles with nematocysts (sea-anemones and zoophytes).

Those with hard prehensile or masticatory organs include :—1. Those feeding by means of a radula (Gasteropods). 2. Those feeding by means of an extroversible proboscis, furnished with hard structures (many Polychæts). 3. Those feeding by means of setæ-covered limbs, with chitinous cuticle, and often with a masticatory gizzard in addition (Crustaceans and Dipterous larvæ). 4. Those feeding by means of a masticatory organ with teeth (regular Echinoids).

Detritus forms the principal food of nearly all the Invertebrate animals of the sea-bottom, next in order of importance being plant-food from fresh benthos plants. The value of the live phytoplankton in this connexion is absolutely minimal, having little more than indirect significance through the medium of the plankton Copepods.

Organic Matter of Sea-bottom in Danish Waters.*—P. Boysen Jensen corroborates the conclusion previously reached by C. G. J. Petersen and himself, that the plant growths of the *Zostera* belt and not the plankton organisms should be regarded as the principal source of the organic matter of the sea-bottom in many of the Danish waters.

The organic matter of the sea-bottom in the more sheltered waters (fjords, etc.) is almost exclusively derived from the *Zostera*. In more open waters, however, such as the Kattegat, the plankton organisms are possibly of some importance as a source of origin of the organic matter of the sea-floor.

The quantity of pentosan in proportion to the amount of organic

* Rep. Danish Biol. Station, xxii. (1914) pp. 1–39.

matter was carefully estimated. The *Zostera* is relatively far richer in pentosan compounds than the plankton organisms. The organic matter of the sea-bottom was found to occupy an intermediate position between the *Zostera* and the plankton with regard to the amount of pentosan contained.

The amount of nitrogenous matter digestible with pancreatin was comparatively small, but the investigations of Biedermann and Moritz point to the conclusion that bivalves are capable of digesting pentosan which is present on the sea-bottom in considerable quantities.

Iodine in Marine Animals.*—A. T. Cameron has enquired into the iodine-content of marine animals in the neighbourhood of Nanaimo, Vancouver Island. It is generally distributed, and seems to occur, as Gautier showed, in organic combinations in the surface-water, in inorganic form in the deeper water. Perhaps the Algæ may, in part, utilize the organic combinations containing iodine.

All the animals examined, except the free-floating forms and the starfish (*Pyknapodia*), showed the presence of iodine in detectable amount. It was very scanty in sea-cucumber and barnacle. In fishes the thyroid is the only organ containing an appreciable amount. In *Squalus sucklii* it was detected in the excretory organs.

Iodine was found in marked quantity in the horny tube secreted by the worm *Diopatra*, in the cellulose ("tunicine") test of the Tunicate *Pyura*, and in the external cuticle of the horse-clam *Schizothærus*. In sponges the iodine is contained in the spongin, a sclero-protein: in Gorgonids in the gorgonin, also a sclero-protein; in the Serpulid tube in conchiolin, also a sclero-protein. In the case of the bivalve *Schizothærus*, the cuticle is probably for the most part a keratin.

Penis-bone in Squirrels.†—Oldfield Thomas finds that the structure of this bone, for which the term "baculum" is suggested, is of service in classifying squirrels. In the common squirrel it is like a spatula, or still more like a half-closed human right-hand, the shaft forming the forearm, the blade of the spatula the hollowed palm, and a small pointed projection on the right side corresponding to an outstretched thumb. Of this type are the bacula of the other Palæarctic species. But all the Indian and Malayan species hitherto referred to *Sciurus* have bacula which are totally different from that of true *Sciurus*, and may be called compound. In all these there are two parts: a shaft, or *capulus*, of varying length, and a separate blade, or *lamina*, attached to the shaft by ligament, and slightly movable upon it. There are two types of compound bacula, respectively more and less specialized. The author shows how the characters of the baculum may be utilized in classification.

Retractor Penis in some Lemuridæ.‡—Ed. Retterer and H. Neuville report the presence of a retractor muscle of the penis in some Lemuridæ.

* Contributions Canadian Biol., 47th Rep. Dept. Fisheries, Ottawa (1914) pp. 51–68.

† Ann. Nat. Hist., xv. (1915) pp. 383–7.

‡ C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 79–80.

In a young specimen of *Lemur mongoz* they found a musculo-elastic band on the rectal surface of the free part of the penis. In structure and position this cord corresponded to the retractor penis in dog and cat. It has doubtless protective value, and it is interesting to find its occurrence in Mammals with a pendant penis.

"Whitebait" of Menai Strait.*—Andrew Scott has inquired into the nature of ten samples of "whitebait" collected between March and September in the weir at Gorad Coch, near the Swilies in the Menai Strait. The result is to show that the whitebait of this locality are young Clupeoid fish, such as sprats and herring, and that young herring 35–67 mm. in length are frequently present. There is considerable difficulty in determining whether the smaller fish, of about 43 mm. in length and under are young herring or some other young Clupeoid. They are scaleless and almost transparent.

Structure of Papuan Limestone of Lower Miocene Age.†—Frederick Chapman gives an analysis of the organic constituents of a limestone from Bootless Inlet, Papua. The important factors indicating Lower Miocene age are the genera and species of *Carpenteria*, *Heterostegina*, *Cycloclypeus*, and *Lepidocyclina*. Besides Foraminifera there were some fragments of Echinoid spines and plates, remains of Polyzoa, and a fish tooth like that of *Chrysophrys*, the sea-bream. This occurrence of a Lower Miocene horizon in Papua is of exceptional interest, as showing the existence of another link in the chain of localities where the beds of the old shore-line of the ancient Tethyan Sea were laid down.

INVERTEBRATA.

Mollusca.

γ. Gastropoda.

Epithelial Cells of Æolids.‡—L. F. Henneguy finds that the large ciliated cells of the intestine and the smaller cells of the epidermis (*e.g.* in *Æolis papillosa*) show the same structure. The cytoplasm contains many vesicles, like elastic bladders, plunged in it. There may be fifty in a cell. They increase the consistence of the cytoplasm and produce a certain elasticity. The turgescence is an adaptation to withstand pressure. An analogous adaptation is the presence of tonofibrils or a thick cuticle. In the Æolids there is a capacity of resisting the pressure of hard bodies, yet the vibratile function persists and the power of absorption.

δ. Lamellibranchiata.

Reproduction of Freshwater Mussels.§—A. D. Howard has made numerous experiments bearing on the propagation of freshwater mussels

* Rep. Lancashire Sea Fisheries Lab., xxiii. (1915) pp. 139–53 (3 pls.).
† Proc. R. Soc. N. S. Wales, xlviii. (1914) pp. 281–301 (3 pls.).
‡ C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 80–2.
§ Rep. U.S. Commissioner of Fisheries, 1914. Appendix iv., pp. 1–52 (6 pls.).

of the *Quadrula* group. The eggs pass from the genital apertures into the suprabranchial chambers of the inner gills, from there to the cloaca, and then back through the suprabranchial chambers to the gills. They are probably fertilized during transition to the gills by sperms introduced with the respiratory current. Some forms carry embryos in all the four gill-plates.

The segmentation is remarkably slow. The eggs of *Quadrula ebena* observed on the morning of May 31 as in the one-celled stage, were only in the two-celled stage in the afternoon. On the second day segmentation had advanced to the four- and eight-cell stages, and on the fourth day sixteen-cell stages predominated.

Specific or narrowly-restricted parasitism was observed in the case of *Quadrula pustulosa*, which is confined to *Ictalurus punctatus*, the channel cat. A similar case is that of the nigger-head (*Q. ebena*), which is confined to *Pomolobus chrysochloris*, as Surber reports. Just as the louse *Goniodes stylifer* is confined to the turkey and *Trichodectes scalaris* to the ox, so the glochidia of these mussels keep in their temporary parasitism to one host. But there are other glochidia which infect many fishes. Thus the hookless glochidia of *Q. heros* were found on Sciænidæ, Siluridæ, and Centrarchidæ, and the hooked glochidia of *Anodonta corpulenta* were found on Sciænidæ, Centrarchidæ, and Clupeidæ.

Some species of fish appear to be very susceptible to infection by glochidia. Thus the sheepshead, *Aplodinotus grunniens*, is found infected with the glochidia of *Lampsilis lævissima*, *L. gracilis*, *L. alata*, *Plagiola donaciformis*, and this may be associated with the fact that it is a mussel-eating fish.

The immunity of some fishes may be in part mechanical, but there is an absence of histological response in some cases, and also a failure on the part of the glochidia to fasten. The normal reaction of the glochidia is to chemical stimulation from the ions of protoplasmic salts diffused from the fluids of the fishes' gills or body. A curious fact is recorded that the immersion of fish in 10 p.c. salt solution increased the rapidity of infection. A fish has usually but a small number of glochidia, but the sheepshead and the "herring" (*Pomolobus chrysochloris*) have been found with thousands.

In general, the hooked glochidia occur on the fins and the hookless on the gills, but there are some apparently constant exceptions. The types of cyst differ considerably. Periods of parasitism vary from twelve days to six months, and there are considerable differences in the degree of development of the larva at the end of the parasitic period.

Howard found a thread gland and larval thread in the mature glochidium of *Quadrula heros* and *Q. plicata*, and he refers to the view of Lefevre and Curtis that the gland is primarily an excretory organ and the thread an excretory product. They do not agree with Schierholz in regarding the thread as important in aiding attachment to fishes. The hookless glochidium of *Quadrula heros* shows the gland and thread more highly developed apparently than in *Anodonta*, and it has the habit of external or fin infection. This suggests that the thread has some function other than excretion alone. If it were excretory

only, it might be expected to persist to the mature state in all glochidia.

Lefevre and Curtis discovered metamorphosis without parasitism in *Strophitus edentulus*. Howard notes that infections have not been found for *Obliquaria reflexa* and *Anodonta imbecillis*, and that in the latter the young mussels lie crowded in the marsupial gills of the parent without any conglutinate structure or placenta. The glochidia taken from *Anodonta imbecillis* did not at first respond to the presence of fishes, but in a postscript the author states that he has been able to secure infections and encystment on fishes with *A. imbecillis* and with *Strophitus edentulus*. In the latter complete metamorphosis was observed, but metamorphosis on fishes was not secured for *A. imbecillis*. There seems no doubt that this species, already eccentric in being hermaphrodite, has a development without parasitism.

Hosts of Glochidia.*—A. D. Howard calls attention to cases in which the glochidia are restricted in their parasitism to particular fishes, e.g. the Warty-Back Mussel to the catfish. The Mucket (*Lampsilis ligamentina*) and Lake Mucket (*L. luteola*) have an extensive range of parasitism on several genera of fishes, while the Yellow Sand Shell (*L. anodontoides*), a closely-related species, is parasitic upon a single genus of fishes (the Short-nosed Gar, *Lepisosteus platosomus*) far removed from the others. Any of the three species (*L. osseus*, *L. platostomus*, and *L. tristoechus*) seems to be a suitable carrier for the mussel in question. The glochidia of *Obovaria ellipsis* remained and passed through the parasitic stage on the sturgeon (*Scaphirhynchus platorhynchus*), while they were promptly shed by the black bass, sunfish (*Lepomis pallidus*), sheepshead (*Aplodinotus grunniens*), and so on. The butterfly shell (*Plagiola securis*), *P. donaciformis*, and a third species, are confined chiefly to one host—the sheepshead.

Arthropoda.

α. Insecta.

Clasping Organs of Insects.†—G. T. Bethune-Baker discusses the more or less external armature at the telum of insects. There are no clasping organs in Thysanura and Collembola, only certain stylets and sensory gonapophyses. In Orthoptera there is a combination of primitive and progressive characters; the cerci are strongly developed, whilst the clasping organs are present, but probably are not strong enough to be of much use. The Thysanoptera seem to have genital characters somewhat like those in Thysanura, confined to sensory gonapophyses and stylets. The clasping organs seem to be modifications of the ninth and tenth abdominal segments. In Lepidoptera, Trichoptera, and Diptera, they are very ancient structures. The Coleoptera do not seem to have true homologues of the Lepidopterous external organs. The same applies to the Hymenoptera. The Odonata are quite by themselves

* Trans. Amer. Fisheries Soc., December 1914, pp. 41–4.
† Trans. Entomol. Soc. London, 1914, pp. cxix–clxviii (19 pls.).

The ædœagus, including penis, vesica, and ejaculatory duct, is common to all insects, though represented in great variety, and is quite distinct from the external clasping organs. The subject is finely illustrated.

Homology of Body Setæ in Caterpillars.*—Y. Hsuwen Tsou has inquired (1) whether or not the setæ on every body segment of any Lepidopterous larva are serially homologous or not, and (2) whether or not the setæ on every corresponding segment of every Lepidopterous larva are homologous to each other. He has established a nomenclature for the body setæ—anterior, dorsal, sub-dorsal, circumstigmatal, lateroventral, pseudopodal, and mid-ventral. Each group is indicated by the initial letter, and each seta by the letter and a number, D_1, P_4, and so on.

The only reliable means of ascertaining the homology of the body setæ of Lepidopterous larvæ is to associate the corresponding positions which the setæ occupy. The setæ of any body segment are homologous both with the setæ of every other segment of the same larva and with the setæ of the same segment of different larvæ.

The setæ may be increased in number and reduced in number as the results of specialization. The thoracic setæ of the larvæ of the sub-order Jugatæ do not differ from the thoracic setæ of the larvæ of generalized Frenatæ in number, but do differ in arrangement of certain groups of setæ. The author regards *Cossus cossus* as the most generalized of the Frenatæ from the fact that it has no additional setæ and retains the first circumstigmatal (C_1) on all the abdominal segments and on the prothorax, while other Frenatæ do not retain this seta.

The abdomen of Lepidopterous larvæ consists of more than ten segments. The setæ of the prothorax differ from those of the mesothorax and metathorax, but they are more similar to the latter than to the setæ of any abdominal segment. The thoracic segments are more generalized than the abdominal segments. The homology of each group of setæ is much more evident than the homology of the individual seta within a group.

Chromosome Groups in Genus Drosophila.†—C. W. Metz has made an interesting study of the types of chromosome group in twelve species of *Drosophila*, and finds indication of an evolutionary series. Five species conform to one type in respect of their chromosomes, other four conform to another type, and three to three additional types respectively —making five types in all. In each type the chromosome group is made up of certain different kinds of chromosomes, distinguished by their size, form and behaviour. The metaphase plates usually stand out as clearly as in diagrams, and there seems no reason to doubt that every chromosome has a character of its own, and that its individuality persists from one generation to another. The phenomenon of the actual pairing of chromosomes in the diploid groups is nowhere so striking as in this genus. Each pair is composed of one maternal and

* Trans. Amer. Micr. Soc., xxxiii. (1914) pp. 223–60 (4 pls.).
† Journ. Exper. Zool., xvii. (1914) pp. 45–58 (1 pl.).

one paternal component. Before every cell division the members of each pair become so intimately united that they may be said to conjugate.

Sterility in Drosophila ampelophila.*—Roscoe R. Hyde has studied a kind of sterility affecting the female insect, and finds that it bears no relation to a low fertility. The kind of sterility which was studied is due to some defect, probably in the oviduct of the female, so that she is unable to deposit her eggs. The defect is transmissible through inheritance by at least some of the brothers and sisters of the affected females when mated to a fertile race, to the grandchildren, but apparently not to the sons, or daughters, or grandsons. It is therefore recessive and affects females only.

The process of inbreeding brothers and sisters cannot be held to be responsible for the condition, but probably serves to bring it out when latent in a strain by making the necessary combinations. The character seems amenable to selection, and can be made to affect fully 50 p.c. of the females, or can be practically eliminated by making the proper selections.

It seems very probable that sterility as it affects the male bears no causal relation with sterility as it appears in the female. The defect in the female behaves after the manner of a Mendelian character, in that it reappears after skipping a generation. The normal function is dominant to the negative condition. An unaffected male can transmit something as a dominant character which ensures the normal egg-deposition in his daughters. The defect is sex-limited in the sense that it affects the female only.

Sex-linked Lethal Factors in Drosophila.†—T. H. Morgan has experimented in reference to lethal factors in this fly and their influence on the sex-ratio. The nature of the inquiry may be stated. A recessive lethal factor is one that brings about the death of the individual in which it occurs, provided its effect is not counteracted by the action of its normal allelomorph. The term is not intended to mean that some poison is produced that destroys the individual, but rather some heritable defect that renders the individual unable to live. Lethal factors may be sex-linked or not, i.e. they may be carried by the sex-chromosome or by an autosome. If the lethal factor is sex-linked it will kill any male in which it occurs, since the male has but one X-chromosome. Such a factor, therefore, cannot be transmitted through the male line, or transferred from one lethal stock to another lethal stock. If two sex-linked lethals should ever occur in the same female, one must have arisen as a mutation independently of the other.

Fertility in Drosophila.‡—Roscoe R. Hyde has studied a "truncate" stock of *Drosophila ampelophila*, differing from the wild stock in having the ends of the wing squared instead of rounded, in having a duration

* Journ. Exper. Zool., xvii. (1914) pp. 141–71.
† Journ. Exper. Zool., xvii. (1914) pp. 81–122 (7 figs.).
‡ Journ. Exper. Zool. xvii. (1914) pp. 173–212 (9 figs.).

of life about half that of the wild fly, and giving rise to a small number of offspring. The hybrid offspring of low-producing truncates and high-producing wild stocks are high producers, and it makes little difference whether the father or the mother is from the low-producing truncate stock. Low production is transmitted through egg or sperm to the grandchildren. The short life is a factor in the low production, but there is more than that. There is incompatibility between the egg and the sperm of the truncates, only one egg in every four or five giving rise to an adult. It is suggested that the truncates have become homozygous for many factors, and that the rise of fertility when crossed into other races is to be explained on the assumption that "the combination formed is heterozygous for more characters upon which fertility depends, and consequently more likely to develop."

Fertility in Drosophila.*—Roscoe R. Hyde, continuing his inquiry into fertility in *Drosophila ampelophila*, has made experiments bearing on the question whether or not a rise in fertility will result when one strain is crossed with another. In the crosses there is no sudden rise in fertility, but, on the other hand, a peculiar relation exists in that the stock in each case having the highest fertility is able on crossing to bring the fertility of the lower stock up to its level, and this is true whether through the male or through the female. High-producing stocks can bring the fertility of low-producing stocks to their level whether descended from the same or from different germ-plasms. Inbreeding does not seem to be the cause of low fertility, but low fertility is likely to accompany close inbreeding, provided it is not guarded against by rigorous selection. The author has also made experiments † bearing on the effects on fertility of crossing within and without an inconstant stock.

Infertility of Rudimentary Winged Females of Drosophila ampelophila.‡—T. H. Morgan has examined the ovaries of many rudimentary females of this fly. In the majority of cases the ovaries become nearly as large as those in the normal female, and while they may contain full-sized eggs, most of the eggs remain immature. Most females lay no eggs. Sometimes a few are laid, and at least some of these hatch. The experimental evidence goes to show that the infertility is due, largely at any rate, to a retention of eggs, even after copulation. The sterility cannot be supposed to be due to any additional peculiarity that has appeared in the rudimentary stock, but must be one of the attributes of the factor for rudimentariness itself.

Orienting Reaction of Blowfly Larva.§—Bradley M. Patten has sought to make exact quantitative measurements of the light reactions of the larvæ of *Calliphora erythrocephala* Meigen. The light was applied as two opposed beams, the intensity of which could be easily controlled

* Journ. Exper. Zool., xvii. (1914) pp. 343–55 (1 diagram).
† Journ. Exper. Zool., xvii. (1914) pp. 356–72 (11 diagrams).
‡ Amer. Nat., xlix. (1915) pp. 240–50 (2 figs.).
§ Journ. Exper. Zool., xvii. (1914) pp. 213–80 (24 figs.).

and precisely measured. The responses to the stimulation produced by two beams of different intensity acting simultaneously on opposite sides of the same animal were measured in angular deflections from an initial path of locomotion.

When the opposing lights were of equal intensity, the average trail of the "standardized" larvæ (those showing a uniform degree of sensitiveness) was within 0·09° of the perpendicular to the line connecting the sources of light. When the opposing lights were unequal, the "average trail" showed a deflection toward the weaker light. The amount of the deflection was definite and constant, within the limits of experimental error, for a given intensity difference between the lights.

The phototactic response of the blowfly larva depends, to a large extent, on the stimulating effect of constant light intensity. The reaction to light of constant intensity follows the Bunsen-Roscoe Law. The evolution of phototaxis is the result of the development, in connexion with photokinesis, of certain factors which modify the action of light on the organism, or indirectly distribute its effects. The critical factors of phototaxis are:—1. A distribution of the stimulant in the field such that a change in axial position on the part of the animal involves a change in the distribution, or intensity, of the stimulant acting on the animal or on its sensitive surfaces. 2. The presence, within the organism, of a mechanism adapted to the reception of differential stimulation, and a transmitting and motor apparatus that produces definite locomotor movements proportional to the intensity of the stimulation.

The "response factor" may be present in the form of a bilateral mechanism, or in the form of a unilateral mechanism that reacts to both sides of the environment because of a rotational method of locomotion. If we include under phototaxis any reaction which involves a definite axial orientation with reference to light, the tropism may be regarded as a special form of phototaxis, in which the response depends on the bilateral structure of the mechanism of response.

Centrifuging Spermatocyte Cells of Notonecta.*—Ethel Nicholson Browne has centrifuged the testes of *Notonecta* in small glass tubes with a little Ringer's solution. Thereafter the testes were teased out on a slide or sectioned. The normal resting spermatocyte cell has scattered mitochondria of two sorts, fibres and spheres, and the nucleus contains a deeply staining karyosphere in which the chromatin is collected. When a cell of this sort is centrifuged, the mitochondria are driven to the distal pole (away from the axis of the centrifuge), where they appear as a deeply-staining mass in which individual bodies cannot be distinguished except along the edge. The mitochondria are therefore the heaviest material in the cell. The rest of the cell is filled with clear cytoplasm. The nucleus goes to the centripetal pole (nearest the axis of the centrifuge), showing that it is of less specific gravity than the cytoplasm. The karyosphere is always driven to the distal end of the nucleus, and in some cases, in fact, it is driven through the nuclear

* Journ. Exper. Zool., xvii. (1914) pp. 337–40 (1 pl.).

membrane. Three layers of materials can be segregated—a cap of oil drops, a clear protoplasmic layer, and a layer of mitochondria. Normal division figures occur in spite of the redistribution of materials.

Blood-Sucking Muscid Larvæ.*—E. Roubaud calls attention to some of these remarkable forms.—1. There are hæmophagous parasites of man, notably *Auchmeromyia luteola*, the larva of which, "ver des cases," is attracted from the soil of huts by the warmth of the body of sleepers. It applies to the skin the free margin of its first post-cephalic segment, and then retracts the pseudo-cephalon, so that adhesion is effected. The piercing of the skin is due to successive scarifications effected by the buccal hooks. The suction is due to the movements of the piston of the pseudo-cephalon. The larva keeps itself erect during the process, the posterior end being quite free. When it is gorged with blood and has a red colour, it falls off on to the ground. It cannot pierce clothes. It can endure fasting for a long time. 2. There are hæmophagous larvæ parasitic on Mammals with naked skin, the aard-vark (*Orycteropus*) and the wart-hog (*Phacochœrus*). The larvæ belong to the genus *Chœromyia*, and they behave like those of *Auchmeromyia*. 3. There are hæmophagous larvæ on birds. Thus in 1844 Dufour found that young swallows had their blood sucked by the larva of a Calliphorid fly (*Phormia sordida* Zett. = *Ph. azurea* Meig.), and this has recently been confirmed by H. du Buysson. The sucker of the larva, figured by Roubaud, is furnished with a marginal collar of radially arranged processes, spine-like, but not very rigid. These larvæ do not show the erection characteristic of those previously mentioned, but lie flat. Roubaud observed their suction on naked parts of the skin of guinea-pig and fowl, and on man. Rodhain has recently observed another hæmophagous larva in the Belgian Congo. It occurred in the nest of *Passer griseus*, and was seen to be able to nourish itself on a fowl.

All the cases known show (1) adhesion by means of the margin of the first post-cephalic segment, which acts like a sucker, (2) scarification by buccal hooks, and (3) suction by the pumping movements of the invaginated pseudo-cephalon. Two conditions must be fulfilled: the skin of the host must be naked, and the host must be at rest. The larvæ cannot move far. The parasitism of *Auchmeromyia* is not known among nomads. The temporary parasitism is a step towards permanent cuticolous parasitism, the "ver des cases" pointing on to the "ver du Cayor," and the *Phormia sordida* to species of *Mydæa* on South American woodpeckers.

Myiasis and allied Diseases.†—E. Roubaud has given an account of the parasites causing myiasis and similar diseases in man and his stock in West Africa. He deals, for instance, with the blood-sucking larvæ of *Auchmeromyia* and *Chœromyia*, with muscid larvæ developing in cutaneous wounds, with deeply penetrating Œstrid larvæ, with "Ver

* C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 92–7 (2 figs.).

† Agents Parasitaires Producteurs de Myiases, etc. Paris: (1914) 252 pp. (4 pls.) See C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 71–2.

du Cayor," which causes a furunculous myiasis, with the Guinea worm, and with a Senegalese pseudomyiasis, spreading in lines, the nature of which is still unknown.

Life-history of Dryinidæ.* — D. Keilin and W. R. Thompson discuss the life-cycle of these Hymenoptera, which occur as parasites in Homoptera (especially Fulgoridæ and Jassidæ). The authors deal with stages from species of *Typhlocyba*, where the parasite occurs in the anterior abdominal segment, surrounded by a cyst due to proliferation of hypodermic cells. As the embryo develops, the cyst enlarges. At a certain stage the larva, curved like a V, protrudes as a hernia on the host. The protrusion never occurs before the host's last moult. The larva protrudes without any great damage to the host, but as it grows the host becomes lethargic. Before pupation the larva begins to devour its host, and leaves it empty. The larva moults, falls to the ground, spins a cocoon, to which sand-grains adhere, and passes the winter as a pupa. The cyst of the early stage of the parasite acts like a placenta, intermediating in the passage of nutrition from host to parasite. It may also be likened to a gall.

Dipterous Parasite of Larval Mycetophylid.†—W. R. Thompson calls attention (1) to Roubaud's report of the parasitism of the larva of a Tachinarian, *Siphona* (*Bucentes*) *cristata* Fabr., in the larva of *Tipula maxima*, within which it is attached to the tracheal system: and (2) to a report by Bezzi and Stein that *Admontia amica* is a parasite of a Tipulid. Such cases of Dipteron parasitic on Dipteron are very rare.

The author reports the occurrence of a Dipterous parasite in a Mycetophilid fly, *Sciara*, where it was discovered by D. Keilin. The parasite remains free in the general cavity of its host, and must utilize the oxygen in the blood. The cuticle is transparent; there are some extremely minute setæ: the bucco-pharyngeal armature is very delicate; the internal tissues are very soft and transparent; the salivary glands are large; there seem to be only two Malpighian tubules. No trace of stigmata or tracheal chambers could be seen. Perhaps the larva is apneustic. In any case, its stigmatic system is less developed than in any other known Tachinarian; for it is probable that the larva is a Tachinarian.

Pipunculids Parasitic in Homoptera.‡—Dr. Keilin and W. R. Thompson describe the occurrence of Pipunculid larvæ (*Ateleneura spuria*) in the abdominal cavity of several species of *Typhlocyba* (Homoptera). As the larva increases in size it compresses all the organs of its host and causes distension of the abdomen. For a time it has its head turned towards the thorax of its host, but after a moult it is turned in the opposite direction. The turning is probably associated with the moult. It has its head towards the genital armature of the

* C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 83–7 (10 figs.).
† C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 87–9 (1 fig.).
‡ C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 9–12 (11 figs.).

host and its posterior stigmata open at the level of the junction of thorax and abdomen on the dorsal side. The hosts are readily recognized by the swollen abdomen and are very sluggish. The Pipunculid larva works its way out of its host, making a rupture between two abdominal segments. It enters the earth and pupates slowly. Occasionally two larvæ occur in one host, but in such cases only one develops. The observers did not see the host's phagocytes attacking the parasites. After the parasite emerges the host is left quite empty.

Attention is directed to the convergence between these Pipunculid larvæ and those of some parasitic Hymenoptera, such as Braconids. The authors note the deposition of the eggs in the abdominal cavity, the delicacy of the larval cuticle, the closed stigmata and the absence of tracheæ in the young larvæ, the presence of an anal vesicle, and the absence of phagocytic cysts.

The apneustic condition, the absence of tracheæ, and the great development of the central nervous system, especially of the ventral chain, are characteristic of the embryos of all the cyclorhaphous Diptera. The reduction of the bucco-pharyngeal apparatus in the first larval stage is to be associated with the internal oviposition and the "plasmophagous" mode of nutrition. The buccal armature is like that of larval Phoridæ and Platypezidæ.

New Thysanoptera.*—Richard S. Bagnall describes *Homothrips distinctus*, g. et sp. n., from Cape Town, differing from all genera except *Rhampothrips* in its three-jointed antennal style; *Megalurothrips typicus*, g. et sp. n., from Sarawak, allied to *Physothrips*; *Isoneurothrips australis*, g. et sp. n., from W. Australia, with all the characters of *Thrips* (+ *Bagnallia*), but having the whole of the upper-vein of the forewing regularly set with setæ as well as the lower; *Tetracanthrothrips borneensis*, g. et sp. n., from W. Sarawak, belonging to the *Trichothrips* group; and various new species, e.g., of *Ecacanthothrips*.

β. Myriopoda.

Symphyla from Algeria.†—Richard S. Bagnall reports on a small collection containing *Scutigerella armata*, *S. immaculata*, *S. spinipes* (previously recorded from the north of England), and *Symphylella vulgaris*.

γ. Onychophora.

Peripatus from Abor Country.‡—Stanley Kemp gives a full account of *Typhloperipatus williamsoni* Kemp, already referred to in this Journal.§ It was first found by the late Mr. Williamson on a plateau above the Dihang River in the Abor country. No member of the Onychophora has been hitherto known to occur within the limits of the Indian Empire. No trace of the eye is visible externally, but

* Ann. Nat. Hist., xv. (1915) pp. 588–97 (2 figs.).
† Ann. Nat. Hist., xv. (1915) pp. 527–8.
‡ Records Indian Museum, viii. (1914) pp. 471–92 (4 pls.).
§ See this Journal, 1914, p. 168.

the optic ganglion is well developed, and has the form of a spherical mass situated laterally at the base of the antennary nerve. The optic ganglion comprises a large number of ganglionic cells, but does not form a solid mass. There is an irregular ramifying cavity lined by a loosely compacted non-cellular structure, which represents the remains of retinal rods. It appears that the ganglionic cells which originally formed a cup-shaped mass round the base of the retina have grown round the base of the rods and have completely enveloped them. The optic nerve is well developed, and is broadly expanded within the ganglion. It extends backwards through the ganglionic substance of the brain, but decreases rapidly in diameter. At its actual point of attachment with the white matter it is exceedingly slender.

The skin overlying the optic ganglion is wholly undifferentiated, and bears papillæ precisely comparable to those of the surface in the near vicinity. The epidermis is not specialized to form a cornea, the lens is entirely absent, and there is no black retinal pigment. The antennary nerve appears to be considerably stouter than usual. Possibly, as some compensation for its blindness, the antennæ are more sensitive in *Typhloperipatus* than in other forms. A curious scale-bearing patch on the lower surface may well be sensory. The brain differs rather noticeably in shape from those of the species figured by Balfour and Bouvier.

The principal characters of the genus are thus summarized. The number of legs is nineteen or twenty. The inner jaw shows a diastema and a saw of denticles. The legs have four complete spinous pads. The nephridial openings of the fourth and fifth legs are situated on the third pad. The feet have two distal papillæ, one anterior and one posterior. The genital opening is between the penultimate pair of legs. There are receptacula seminis, with two ducts opening into the oviducts. Receptacula ovarum are present. The oviducts are united for some distance in front of the ovaries. The ovaries are completely fused, with a single cavity. They lie closely pressed against, but not directly attached to, the floor of the pericardium, to which, however, they are connected posteriorly by means of a funiculus. The ovary is exogenous, i.e. it is studded with follicles, in which the maturing ova lie. The ova are large and heavily charged with food-yolk; they measure about 1·5 mm. in their long diameter. The embryo is without a trophic vesicle. The uterine embryos are of about the same age. The unpaired part of the vas deferens is of very great length. The spermatophores are long, with a horny coat and cap. The skin-pigment is brown, disappearing in course of time in alcohol. Well-developed coxal glands are present in the legs. A single crural gland is present in the male in each of the two pre-genital pairs of legs. The accessory glands of the male open separately on the ventral surface between the genital opening and the anus.

The absence of eyes, and the peculiar patch of highly modified scales on the lower surface of each antenna, may be regarded as evidence of specialization. They are not shared by any other genus of Onychophora. The affinities of *Typhloperipatus* are primarily with its nearest geographical neighbour, *Eoperipatus*.

δ. Arachnida.

Acarina of Clare Island.*—J. N. Halbert deals with terrestrial and marine mites found during the survey of Clare Island and the surrounding district. He has already reported on eighty fresh-water mites, and he now adds 186 to the list of Clare Island Acarina, making a total of 266 species. It has been found necessary to define three new Gamasid genera. Descriptions and figures are given of twenty-two new species and five new varieties. Apart also from the extension in the known range of many species, at least ninety are recorded for Britain for the first time (this being in part due to the scarcity of British records for Gamasoidea and Tromboidea), and at least 156 species were previously unrecorded for Ireland.

The author points out that the Gamasoid group is in need of a general revision. Many of the most interesting Acarina found during the Clare Island Survey belong to this group. They are small and medium-sized mites, of very varied habits and structure. The free-living forms occur among moss, in fungi, under bark of decaying trees, etc.; some are found only in ants' nests; others must be sought for between tide-marks on the shore; others, again, are parasitic.

Of the Oribatoidea, sixty species were collected, and it is interesting to note that only two of these (and a few varieties) are not dealt with in Michael's admirable monograph. The occurrence of the marine Tyroglyphid, *Hyadesia fusca*, is interesting, and also the presence of *Tyroglyphus wasmanni* in the nests of the Black Ant. Some minute marine Halacaridæ were collected. A number of littoral forms were found, notably a peculiarly isolated form, *Thinozercon michaeli*, which seems to require a new family of Gamasoidea, and the new genus *Haluropoda*, from the shore and salt marshes. Many forms were got below high-tide mark, undergoing continual immersion. An undoubted Sphagnum fauna occurs in very wet places.

ε. Crustacea.

Reptant Decapoda of Irish Coasts.†—C. M. Selbie reports on the Palinura, Astacura, and Anomura (except Paguridea) of the coasts of Ireland. The collection includes thirty-one species, four of which are new to science, eleven new to the British, and sixteen to the Irish marine fauna. The feature of the collection is the large number of specimens belonging to the family Eryonidæ, of which no examples had previously been taken within the British marine area. Four species of *Polycheles* and four of *Eryonicus* were taken, three of the latter—*E. hibernicus*, *E. scharffi*, and *E. kempi*—being new. "Perhaps the most interesting specimen in the whole collection is a very young *Eryonicus*, only 7 mm. long, in which only the first two pairs of pereiopods are developed, the rostrum has the form of a long median spine, and the abdomen is very small. The most striking fact, however, is

* Proc. Roy. Irish Acad., xxxi. (1915) Clare Island Survey, pt. 39, ii. pp. 45–136 (5 pls.).

† Sci. Invest. Fisheries Ireland, 1914, No. 1, pp. 1–116 (15 pls.).

the presence of exopodites on the pereiopods and on the second and third maxillipedes. The specimen is, in fact, an *Eryonicus* in the *Mysis* stage of development." A new species of *Palinurus*, closely allied to *P. vulgaris* and *P. gilchristi*, is suggested. All the specimens in the collection were from the bottom except *Eryonicus*, which is a free-swimming form.

Palæmons of the Philippine Islands.*—R. P. Cowles deals with the species of *Palæmon* represented in the lakes and rivers of the Philippines. They are abundant and are much fished for. A full description is given of the external features of a typical *Palæmon*, and the various species are carefully described, including *P. philippinensis* sp. n., and *P. jaroensis* sp. n. There are excellent illustrative figures.

New Genus of Terrestrial Isopods.†—W. E. Collinge reports on a small collection of terrestrial Isopods from the Abor Expedition in the foot-hills of the Eastern Himalayas, which includes two new species of *Cubaris* and a new genus *Burmoniscus* established for a blind cavernicolous form, remarkable in having a deep brown colour.

New Caprellid.‡—A. G. Huntsman describes *Mayerella limicola* g. et sp. n. from the Bay of Fundy. Almost every character possessed by the new form is to be found in one or other of the known genera, but the combination it shows is new. The most striking features are the presence of two joints in each of the first and second pairs of pereiopods, of three joints in the third pair, and of three joints in the mandibular palp (the last with a single bristle). The abdomen of the female has two pairs of spines (perhaps representing appendages), and the abdomen of the male has a pair of rudimentary appendages and a pair of large spines behind these, representing another pair. The habitat was at 5–50 fathoms on muddy and muddy-sand bottoms in the Bay of Fundy.

Entomostraca of Georgian Bay.§—G. O. Sars reports on a collection including nine Cladocera (e.g. *Daphnia hyalina* var. *oxycephala* G. O. Sars, *Hyalodaphnia retrocurva* var. *intexta* Forbes, and a very small variety of *Bosmina longirostris*), six Copepods (e.g. *Epischura lacustris* Forbes, and *Diaptomus oregonensis* Lilljeb.), and one Ostracod (*Cyclocypris serena* Koch). Sars upholds the species *Cyclops thomasi* Forbes and *C. edax* Forbes.

Fresh-water Entomostraca of North America.‖—Ada L. Weckel has compiled for students of micro-biology an account of the free-swimming fresh-water Entomostraca of North America. Keys are given

* Philippine Journ. Sci., ix. (1914) pp. 319–403 (3 pls. and 1 fig.).
† Records Indian Museum, viii. (1914) pp. 465–9 (3 pls.).
‡ Suppl., 47th Rep. Dept. Fisheries, Ottawa, 1915, pp. 39–42 (2 pls., not in copy received).
§ Suppl. 47th Rep. Dept Fisheries, Ottawa, fasc. ii. (1915) pp. 221–2
‖ Trans. Amer. Micr. Soc., xxxiii. (1914) pp. 165–203 (14 figs.).

for the determination of most of the species of Phyllopods, Copepods, and Ostracods, a laborious piece of work which will be useful to many.

Ostracods from Australia.*—Frederick Chapman reports on a collection of Ostracods made by the F. I. S. 'Endeavour' from the east coast of Tasmania and off Cape Wiles, South Australia. He deals with forty-five species and two varieties, nearly all new to that area of the Southern Ocean. There are some new species: *Macrocypris gracilis*, *Xestoleberis davidiana*, *Cytheropteron dannevigi*, and *C. fimbriatum*, and some new varieties. Several of the deep-water species, such as *Argillæcia affinis* and *Bythocythere retiolata*, have hitherto been recorded only from Funafuti in the South Pacific. A number of very rare forms occur, such as *Eucythere declivis*, a North Atlantic species, only once recorded from the southern hemisphere.

Annulata.

Parasitic Oligochæte from Gill-chamber of Land Crabs.†—H. A. Baylis has described *Enchytræus carcinophilus*, which occurs frequently and in considerable numbers in the gill-chamber of *Gecarcinus lagostoma* from South Trinidad. He describes another species, *E. parasiticus* sp. n., from *Gecarcinus quadratus* from Clarion Island (Pacific). Syrphid larvæ were found in *Cardisoma hirtipes* from the Admiralty Islands, and in *Gecarcoidea lalandii* from Christmas Island; but these may have entered accidentally, and possibly after the death of the crabs. It is not easy to see how the Oligochæte worms subsist, for they are without jaws. Perhaps they eat mucus.

Polychætes collected by the 'Hirondelle' and 'Princess Alice.'‡ Pierre Fauvel gives in a large and stately memoir an account of the non-pelagic Polychætes collected on the various voyages of the 'Hirondelle' and the 'Princess Alice.' He deals with no fewer than 288 species, in 158 genera, and twenty-eight families. Five genera and twenty-one species are new to science. Another new genus, Phalacrostemma, was described by Marenzeller before Fauvel took up the work. Most of the specimens were collected in the areas off Spitzbergen, Norway, the Bay of Biscay, the Azores, the Canaries, and Cape Verd. Seventy-five species were found below 1,000 metres, fifteen below 2,000, eighteen between 4,000 and 5,000, three between 3,000 and 4,000 (a depth at which few trials were made). The species from the greatest depths include few distinctive forms; most are also littoral and common. The new genera are *Pseudohalosydna* near *Halosydna*, *Palmyreuphrosyne* near *Euphrosyne*, *Paralacydonia* near *Lacydonia*, *Pseudocapitella* near *Capitella*, and *Spirodiscus*, a remarkable Serpulid. The author is to be congratulated on the completion of a gigantic piece of work.

* Biol. Results 'Endeavour,' iii. (1915) pp. 34–51 (2 pls.).

† Ann. Nat. Hist., xv. (1915) pp. 378–83 (1 fig.).

‡ Resultats des Campagnes Scientifiques, par Albert 1er, Prince Souverain de Monaco, xlvi. (1914) pp. 1–432 (31 pls.).

New Species of Henlea.*—Paul S. Welch describes *Henlea tubulifera* sp. n. from the shore of Burt Lake, Michigan. There are already more than fifty species in this Enchytræid genus. The new form is closely related to *Henlea moderata* Welch, but there are distinct differences in the brain, peptonephridia, clitellum, somites, setæ, and penial bulb. None of the other American species of the genus appear to be at all closely related. The specimens were obtained under decaying bark and among debris of fallen timber.

The lymphocytes are large and numerous, and mostly circular in outline. They are sparse at the anterior end, but near the ninth segment they fill the whole body cavity. Two peptonephridia are present, one on the dorsal and the other on the ventral side of the digestive tract in the sixth segment. Both adhere very closely to the walls of the gut. Each is an irregular, tubular mass showing ramifying lumina and nucleated walls. The dorsal peptonephridium gives off a few irregular branches which extend into the cœlom. The author gives a detailed account of the intestinal diverticulum, which is made up of a series of branching, rather thick-walled tubules which arise from the gut in the posterior part of the eighth segment and extend towards the head.

Nematohelminthes.

Philippine Filaria.†—E. L. Walker gives a careful description of the adults of the *Filaria* found in the Philippine Islands. Ashburn and Craig, who discovered Filariæ in the blood of a native, referred them to a new species, *F. philippinensis*, but Walker believes that it is identical with *F. bancrofti*. All the essential external features correspond, e.g. the two series of tiny papillæ on the head, the delicate cross-striations, the pyriform enlargement of the receptaculum seminis, the tendril-like coiling of the male's tail, the two dissimilar spicules, the three pairs of post-anal papillæ, the numerous (about thirty-two) pre-anal papillæ, and the sheath of the larva.

Genus Dermatoxys.‡—L. G. Seurat finds that *Dermatoxys veligera* (Rud.), which Schneider established for a parasite in *Lepus brasiliensis*, occurs in Algiers in *Lepus kabilicus*, and that it is very closely related to *D. getula*, which he found in a squirrel in Morocco. A careful description of *D. veligera* is given, and it is shown that the genus is closely related to *Oxyuris spinicauda* Duj., a central type among Oxyurids. In the structure of the œsophagus and in the shape of the tail in the male, *D. veligera* appears to be one of the most evolved of the Oxyurids.

Platyhelminthes.

Toxic Action of Intestinal Worms.§—Demettre Em. Paulian refers to the view that nervous troubles are brought on by irritation of the

* Trans. Amer. Micr. Soc., xxxiii. (1914) pp. 155–63 (1 pl.).
† Philippine Journ. Sci., ix. (1914) pp. 483–91 (1 pl.).
‡ C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 75–9 (4 figs.).
§ C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 73–5.

intestinal nerve-endings, and to the view that the nervous troubles are due to toxins. Removal of the worms is sometimes followed by a disappearance of the nervous trouble. The author experimented with extracts of Platyhelminthes and Nematodes and found that these brought on nervous troubles. His fingers, nose, and eyes were affected, which points to the entrance of toxins through the skin and to their being volatile. The phenomena of anaphylaxis were clearly observed. The toxins do not differ in constitution from albuminoid substances in general.

New Trematode from Terrapin.*—F. D. Barker and — Parsons describe *Cotylaspis cokeri* sp. n., a new Aspidobothrid Trematode from Lesseur's terrapin. The living specimens were light red in colour. "The body resembles a miniature turtle, with its anterior slender, very active and distensible neck region attached to the dorsal and anterior portion of the much thickened oval body region." The neck is as long as the body. The entire worm measures 1·2–1·5 mm. long by 0·6 mm. wide. The ventral region is covered by a shield which bears three rows of suckers. The median row has twelve, the lateral rows ten each. In a hundred specimens the number was constant, save in one which had eleven acetabula in the marginal rows and thirteen in the median row, thirty-five in all instead of thirty-two. Twenty-two marginal sense-organs are present—small clear oval areas at the outer marginal end of each ridge between two suckers. The internal characters are also described.

Terrestrial Planarians from Abor Country.†—R. H. Whitehouse reports on an interesting collection made by Mr. Kemp in the Abor Country. It includes five new species of *Bipalium*, and one new species of each of the genera *Placocephalus*, *Pelmatoplana* and *Cotyloplana*. The size of *Bipalium giganteum* sp. n. is remarkable, for the largest attained a length of 217 mm. and a breadth of 15 mm., and that in a spirit specimen.

Effect of Section in Planarians.‡—C. M. Child finds that a temporary increase in the rate of metabolism, a "stimulation" lasting for several hours at least, results from the act of section. The temporary increase in the rate of metabolism varies in amount inversely as the length of the piece, long pieces being very slightly or not at all stimulated and short pieces strongly stimulated. The increase is least in front, greatest behind—the differences being expressions of the "axial gradient." The shorter or the more posterior the piece, the greater the degree of stimulation and the less the frequency of head-formation. After the increase in the rate of metabolism there comes a gradual fall. Twelve hours after section the rate may be as low as, or lower than, that in corresponding regions of intact animals. After three or four days the rate of metabolism begins to rise as reconstitution proceeds. The rise is relatively permanent and constitutes physiological

* Trans. Amer. Micr. Soc., xxxiii. (1914) pp. 261–2.
† Records Indian Museum, viii. (1914) pp. 455–64 (2 pls.).
‡ Journ. Exper. Zool., xvi. (1914) pp. 412–41 (4 figs.).

rejuvenescence. Its amount depends on the degree of reconstitutional change, and the size and region of the piece. It disappears as the animal increases in size and age.

Head-regeneration in Pieces of Planaria.*—C. M. Child continues his studies on "the dynamics of morphogenesis and inheritance in experimental reproduction," dealing in the present instance with head-determination in *Planaria dorotocephala*. He has previously shown that the frequency of head-formation in isolated pieces of this Planarian varies with size of piece, region of body, and various external conditions which can be controlled experimentally. He now finds that whether or not a head shall arise at the anterior end of an isolated piece is determined so fixedly during the first six or eight hours after section that head-formation cannot afterwards be prevented by conditions which do prevent it when acting immediately after section. Head-determination undoubtedly begins immediately after section.

The period during which head-determination occurs is the period of stimulation following section, and in general the more a piece is stimulated by section the less likely it is to produce a head. Head-formation is a process opposed or antagonistic to the maintenance of the piece.

The development of a new head on a headless piece is not the restitution of a missing part, but the first step in the development of a new individual. Whether a head is to develop or not depends primarily on whether the cells which give rise to new tissue at the anterior end of the piece become physiologically isolated to a sufficient degree to develop independently of other parts of the piece, or whether other parts prevent this development. In the former case a head arises, in the latter the piece remains headless.

If the group of cells which gives rise to the embryonic tissue at the anterior end of the piece is designated x, the similar group at the posterior end, z, and the remainder of the piece, y, the head-frequency in pieces may be expressed in a very simple form, viz., head-frequency $= \frac{\text{rate } x}{\text{rate } y}$. Tail-frequency, on the other hand, is directly proportional to rate y.

In pieces of considerable length the new head is localized at the anterior end of the piece because the axial gradient determines that the cells at this end are physiologically isolated to a much higher degree than the cells at the posterior end. A group of cells developing independently at a transverse-cut surface gives rise to a head, but when developing in subordination to other parts, gives rise to a posterior end. In short pieces, biaxial heads, biaxial tails, or reversal of polarity may occur according to the relations between the rates of the regions x, y, and z. The author concludes that "a single fundamental reaction system is the basis of development and inheritance in each species, race or individual. The apical or head region, or the dominant part of that region, represents the fundamental reaction more nearly than any other part of the organism."

* Journ. Exper. Zool., xvii. (1914) pp. 61–79 (2 figs.).

Incertæ Sedis.

Bryozoa of Georgian Bay.*—H. T. White reports on seven species and one variety of *Plumatella*, from the Georgian Bay region. He divides *Plumatella polymorpha* Kraepelin into *P. repens*, *P. fungosa* and *P. appressa*. The well-known *Pectinatella magnifica* and *Cristatella mucedo* are also reported.

Australella and Allied Polyzoa.†—Nelson Annandale discusses the genus *Australella* which he established in 1910 and referred to the Lophopinæ. He now recognizes it as one of the Plumatellinæ and defines it as follows:—Plumatellinæ in which the colonies are recumbent and dendritic, but enclosed in a uniform apparently structureless jelly that fills up the interstices between individual zoœcia and branches. There is no stolon; the zoœcia arise directly one from another. Individually they are semi-recumbent, the proximal part of each resting, when the branch to which it belongs is fully formed, on the object to which the colony is fixed, while the distal part is almost vertical. The polypide is normal; it has some forty to sixty tentacles, which are moderately or very long. The lophophore generally resembles that of *Plumatella*. The statoblasts are large (0·4–1 mm. long), but as a rule smaller than those of the Lophopinæ. They resemble the free statoblasts of *Plumatella* in structure, and have neither marginal processes nor terminal prolongations. The genus is represented in Australia, India, and South America. Three species are dealt with, as also a new variety of *Plumatella punctata* and two species of *Stolella*.

Rotatoria.

Sex-determination in Hydatina senta.‡—David D. Whitney finds that in the parthenogenetic reproduction of this Rotifer the influence of the diet acting upon the grandmother determines the sex of the grandchildren. A continuous diet of the colourless Flagellate, *Polytoma*, causes female grandchildren to be produced. A sudden change of the diet from *Polytoma* to an abundant supply of the active green *Dunaliella*, another Flagellate, causes male grandchildren to be produced. The regulation of the sex-ratio in the parthenogenetic reproduction of *Hydatina senta* can thus be controlled by the food conditions.

Inheritance of Hydatina senta.§—A. Franklin Shull obtained two parthenogenetic lines of this Rotifer from England and from Nebraska. They were found to differ in important respects. The eggs of the Nebraska line were larger than those of the English line. Measurements to demonstrate this difference were made only upon eggs laid in the first twenty-four hours of egg-laying of any female, because it was found

* Suppl. 47th Rep. Dept. Fisheries, Ottawa, 1915, fasc. ii. pp. 195–9.
† Records Indian Museum, xi. (1915) pp. 163–9 (2 pls.).
‡ Journ. Exper. Zool., xvii. (1914) pp. 545–58.
§ Journ. Exper. Zool., xviii. (1915) pp. 145–86.

that the eggs of one female gradually increased in size with increasing age of the mother. The Nebraska eggs developed in about two hours less time, on the average, than did the English eggs, and the time of development was much more uniform than that of the English eggs. The rate of egg-production in the Nebraska line was lower than that in the English line, being a little over twelve per day per female in summer in the former line, fifteen per day in the latter. Inasmuch as the Nebraska eggs were the larger, the volume of egg-substance produced in a given line by a single female was approximately equal in the two lines.

More than 50 p.c. of the eggs of the English Rotifers were laid at the surface-film of the water during the summer; less than 10 p.c. of the Nebraska eggs were laid at the surface, the remainder being cemented at the bottom of the dish. The reason for this difference in the location of the eggs is not known; it may be due to a difference in the demand for oxygen. Brief experiments tend to show that the difference in place of egg-laying is not due to a difference in permeability. Temperature appears to modify the percentage of eggs laid at the surface.

The foot-muscles of the Nebraska females responded more vigorously to chemical stimuli than did those of the English females, so that when the animals were killed in a fixing fluid the foot of the Nebraska females was often retracted completely within the body, that of the English females being much more extended.

Reciprocal crosses were made, and the inheritance of the above-mentioned characters was traced through six filial generations. The inheritance of the rate of egg-production and of the uniformity of the time of egg-development was too irregular to summarize. As to the other characters, in F_1 the English characteristics were dominant; in F_2 there was no evidence of segregation, all the lines showing the English characteristics; in F_3, with one exception, all the lines were like the English line in each of the four characteristics, the one exception being a line laying eggs of intermediate size. In F_4 there was one line (perhaps also a second) that was exceptional in showing eggs intermediate in size, while all the other characters of this line, and all four characters in the other lines, were like those of the English line.

The experiments show much less segregation than was to be expected. The characters of the English line appear to hang together, the transmission of one being the same, with a few exceptions, as that of all the others. It may be that the genes for the four characters are somehow associated. But the facts are peculiar.

Echinoderma.

Ciliation of Asterids.*—James F. Gemmill describes the ciliary currents in four species of starfishes—*Asterias rubens*, *Solaster papposus*, *Porania pulvillus*, and *Astropecten irregularis*. The arrangement is constant for all individuals in each of the species, and, except as regards external surfaces, is practically the same in all the species. Everywhere the arrangement of the currents corresponds to physiological needs.

* Proc. Zool. Soc., 1915, pp. 1–19 (3 pls.).

The direction of ciliary action on the different surfaces was studied by pinning out fresh living preparations from healthy specimens, in sea-water with fine carmine particles in suspension, and then examining under strong reflected light with the help of a Swift-Stevenson binocular Microscope. Occasionally, lamp-black or dead sperm of the sea-urchin was used instead of carmine. In the case of the ampullæ and sucker-feet the corpuscles of the water-vascular fluid served, under bright illumination, to demonstrate the currents, but the results thus obtained were confirmed by the use of carmine injections

There can be little doubt that all over the surface of the body the ciliary currents subserve local respiratory purposes, a function of much importance in connexion with the great superficial nerve-tracts, inasmuch as these tracts cannot readily receive adequate oxygenation from the perihæmal fluid bathing their deep surfaces. The currents along the ambulacral grooves are centripetal; fresh water is thus always being brought along them towards the nerve-ring and centre of the disk. This may be important during periods when the starfish is stationary, as in feeding, or is wholly or partly buried in sand (*Astropecten*). Palpules are sometimes introverted (*Porania*), and as the spiral ciliation of their epidermal surface keeps this surface bathed with changing water, the respiratory function will not completely cease.

The ciliation on projecting parts is, on the whole, from the attached to the free extremities, thus promoting the removal of the debris. In *Porania* and *Solaster*, particularly in the smaller specimens, the skin on the aboral aspect between the gills and spines is ciliated so as to collect particles towards the anus, and throw them up therefrom in a perpendicular stream, from under which the starfish is continually walking away in the ordinary course of its movements. In *Asterias* the skin is too thickly covered with gills, spines, and pedicellariæ to exhibit such an arrangement of currents, but the various structures named serve as the starting-cones of minor ascending currents everywhere on the aboral surface of the disk.

The lining of the perivisceral cavity is richly ciliated, and the ciliation produces constant and complete mixing of the cœlomic fluid in the interior of the disk and arms. Great centripetal currents flow along the infero-lateral angles of the arms and, reaching the splanchnopleure of the gut-wall, are swept aboralwards and are next driven centrifugally outwards towards the arm-tips by the cilia on the aboral body-wall and on the radial and rectal cæca. There appears to be a certain amount of circular movement on the part of the cœlomic fluid in the dextral or watch-hand direction as viewed aborally. Continual changing of the fluid inside the gills also occurs.

The endoderm lining of the gut is also ciliated, and the major result of this is to effect sweeping from mouth to anus, but we have also to recognize certain secondary results ensuring: (*a*) mixing and delay within the main gastric cavity, and (*b*) circulation within the cæcal outgrowths.

The aboralward ciliation of the lining of the axial sinus is also of importance, since by its means particles may be swept from the axial sinus into the stone-canal or the pore-canals. The fact that the

perihaemal spaces are ciliated does not seem to have been previously ascertained. The absence of ciliation from the lining of the peribranchial spaces is noteworthy.

The relation of larval to adult ciliation is discussed. While it is true that the larval ciliation passes into that of the adult, the changes in shape and structure which take place at metamorphosis are so profound that in the end only a few details of correspondence between the two systems can be made out.

In the case of *Porania pulvillus* there is a definite arrangement for ciliary feeding, and experiments show that this kind of feeding actually takes place. As regards *Astropecten* it is also shown, so far, that the arrangement of the actinal and abactinal cilia makes ciliary feeding possible. In *Solaster papposus* ciliary feeding probably takes place, but in an entirely different degree. The other starfishes examined gave negative results. It may be that the hypothetical fixed ancestor fed by ciliary activity during the time when it was becoming, and for some time after it had become, an Asterid.

Mechanism of Fertilization in Arbacia.*—Frank R. Lillie finds that unfertilized ova in sea-water produce large quantities of a substance which he calls fertilizin. This is conceived of as reacting with the sperm (its "spermophile" side-chain) and with the egg (its "ovophile" side-chain). The secretion begins presumably in the ova, with breaking of the germinal vesicle. Although the jelly is saturated with it, and liberates it by solution in the sea-water, eggs without jelly continue to secrete it for three days, at least, during repeated washings, or as long as they remain alive. The spermatozoa of *Arbacia* possess extreme avidity for the fertilizin, and bind it in definite amounts. In the case of fresh active sperm the binding is evidenced by reversible agglutination of the spermatozoa. But a stale sperm suspension may also bind it, although the agglutination does not take place, except in high concentration. The fertilizin of *Arbacia* eggs does not combine with *Nereis* sperm.

A substance, named anti-fertilizin, may be extracted from *Arbacia* eggs, by breaking them up or by extracting them in distilled water, which has the property of combining with the spermophile group of the fertilizin. It is present in sufficient amount to neutralize all the fertilizin contained in the eggs, excluding the jelly. When the fertilizin is extracted from the eggs by repeated washings, they are no longer capable of fertilization. Fertilized eggs produce no more fertilizin; that present at the moment of fertilization is neutralized by anti-fertilizin. Eggs with membranes formed by butyric acid become incapable of fertilization; and they contain no free fertilizin.

The blood of male and female sea-urchins contains a varying amount of a substance which inhibits fertilization without exerting any injurious effect upon either the sperm or the ova. This substance is probably more abundant in the blood of mature individuals than in others. The inhibitor does not act by blocking the combination of the

* Journ. Exper. Zool., xvi. (1914) pp. 523–30 (1 fig.).

sperm receptors with the fertilizin, for it has no inhibiting effect upon the agglutinating action of the fertilizin. It acts by occupying the ovophile group of the fertilizin, thus preventing action of the latter upon the egg by union with egg-receptors. This conclusion is demonstrated by the fact that the inhibitor may be entirely neutralized by a sufficient quantity of the agglutinating substance.

Lillie's general idea is that the formation of the fertilization membrane is due to the activation of an ovogenous substance (fertilizin). Following insemination, any excess of fertilizin is bound, or neutralized, by another ovogenous substance (anti-fertilizin), and polyspermy is thereby prevented. The intimate nature of the reactions that occur remains unknown, but as a mode of formulation Lillie expresses them, in terms of Ehrlich's immunity hypothesis, as definite lock-and-key chemical combinations.

Cœlentera.

Development of Mesenteries in Anthozoa.*—Thomas Clachar Brown comes to the following conclusions as the result of his studies.

All Anthozoa, Palæozoic, Mesozoic, and Modern are derived from one common stem-form in which the zooids were bilaterally symmetrical and probably had eight mesenteries.

One branch from this common stem, arising early in the Ordovician, leads up to the modern Alcyonaria (Octocoralla). To this grand subdivision probably belong all such genera as *Columnaria*, *Favosites*, *Heliolites*, *Syringopora*, etc., which are either without septa, or have apparent septa (pseudosepta) or septal spines which bear no direct relation to the soft parts of the zooid either in number or in position.

Another branch from this common stem, likewise arising early in the Ordovician, embraces the typical tetramerous corals of the Palæozoic—the Rugosa, having eight primary mesenteries and four primary septa, with secondary septa inserted in the four primary exocœles in a unilateral pinnate manner, and with tertiary septa inserted late in life in the secondary exocœles. This branch of the Zoantharia became extinct, in North America at least, at the close of the Palæozoic.

Another branch from the common stem gave rise to the Mesozoic and later Zoantharians—Actinians, Scleractinians, Zoanthids, and Cerianthids. All of these pass through an eight-mesentery (Edwardsian) stage in their development, but the great majority of them acquire a later secondary radial symmetry. The particular mode of arriving at this six-fold symmetry varies greatly in the different subgroups.

Gonophores of Tubularidæ.†—Hjalmar Broch finds that the gonophores of Tubularids show a very interesting series, which corroborates the interpretation of the sessile gonophore as a reduced Meduseoid. In the female gonophores of *Tubularia indivisa*, the radial canals are seen in the earlier stages and afterwards disappear. This must mean that the gonophores of ancestral forms had well-developed radial canals.

* Amer. Journ. Sci., xxxix. (1915) pp. 535–42 (11 figs.).

† K. Norske Vidensk. Selsk. Skrifter, 1914, No. 2, pp. 1–17 (4 pls. and 1 fig.).

The female gonophore of *T. regalis* is practically a fixed Medusoid, except that the tentacles are represented by longitudinal ribs. In *T. asymmetrica* one of the radial canals is retained in full expression, while the others are reduced, thus showing an approximation to the *Hybocodon* Medusoid, in which one radial canal is stronger than the others, and bears fully-developed tentacles, while the others have the tentacles reduced or absent. In *T. larynx* the radial canals are indicated, but have no lumen. The greatest reduction is seen in the gonophores of *Corymorpha grœnlandica* and in the male of *Tubularia regalis* and *T. indivisa*, where all traces of radial canals have disappeared, the circular canal is just hinted at, and the lumen of the bell has gone

Porifera.

Indian Clionidæ.*—Nelson Annandale gives an account of the Indian boring sponges of the family Clionidæ. Of the six genera recognized by Topsent, viz. *Cliona*, *Clionopsis*, *Dotona*, *Thoosa*, *Cliothosa*, and *Alectona*, all are represented in Oriental waters save *Clionopsis*, but Annandale is not satisfied that *Cliothosa* is more than a phase of certain species of *Thoosa*. The author describes *Cliona annulifera* sp. n., *C. acustella* sp. n., *Thoosa lævigaster* sp. n., and *T. investigatoris* sp. n. The last secretes a horny covering for its growing-points when they come in contact with foreign bodies. Where such a covering occurs there are nodular amphiasters with nearly spherical lateral and terminal bosses covered densely with minute straight spines. If the covering is very thick a number of these spicules can usually be discovered in which the spines on the nodules seem to be completely worn away and the nodules themselves even to some extent destroyed. This suggests that the spicules of this peculiar type play an important part in the perforation of the compact outer layers of the shell in which the sponge burrows.

Sponges of Spain.†—Francisco Ferrer Hernández continues his account of the sponges of Cantabria, and deals with the Myxospongida, Tetraxonida, and Triaxonida. The majority are common to southern French and British waters, but there are some northern forms like *Craniella cranium*, *C. zetlandica*, and *Thenea muricata*. Five species are also found in the Mediterranean, *Plakortis simplex*, *Stelletta simplicissima*, *S. pumex*, *Rhinaxinella pyrifera* and *Petrosia dura*. Some more eastern forms also occur, like *Chalina rectangularis* and *Raphidophlus filifer*.

Protozoa.

Effect of Thyroid on Division Rate of Paramecium.‡—Waldo Shumway has made a number of interesting experiments on the effect of thyroid and thymus added to the diet of a pedigreed line of *Para-*

* Records Indian Museum, xi. (1915) pp. 1–24 (1 pl. and 4 figs.).
† Trabajos Mus. Mac. Madrid, Ser. Zool. Num. 17, pp. 1–46.
‡ Journ. Exper. Zool., xvii. (1914) pp. 297–314 (3 figs.).

mecium aurelia during four hundred and twenty generations. These experiments have shown that the effect of the thyroid is to increase greatly the rate of division, except at the time when the line was nearing the close of its cycle. The effect disappears after feeding with thyroid is stopped. Similar treatment with thymus gave negative results. It was shown that the Infusorians actually ingest and probably digest particles of thyroid. It is suggested that the effect of the thyroid is primarily upon the metabolic activities of the cell, and, further, that at the close of the life-cycle some element of the protoplasm necessary to digestion is lacking, thus inhibiting the effect of the thyroid.

Feeding Reactions of Bursaria.*—E. J. Lund has studied selection in ingestion and extrusion of particles in this Infusorian. It has three ways of rejecting solid particles. These are (*a*) the path of total rejection, shown by particles that never enter the oral apparatus: (*b*) the path of rejection of large particles, which are made to retrace the path by which they entered; and (*c*) the path of rejection of small particles, which leave the oral pouch by way of the base of the oral sinus and are passed backward over the ventral side of the body.

No definite path is followed by the food-vacuoles during digestion, and in their passage through the cytoplasm. Residues are got rid of from a small area on the mid-dorsal side of the cell. The amount of food eaten and the rate at which it is eaten depends on the physiological state of the cell, i.e., "the condition as a whole, of the equilibria in the physical and chemical reaction system, the cell, at a certain time in the duration of its existence." The rate of feeding is not affected in proportion to the concentration of the food (yolk-grains) in suspension. Mechanical stimulation decreases the rate of feeding or inhibits it, roughly in proportion to the degree of stimulation. Rise in temperature increases the rate of feeding on yolk. Continuous action of white light of high intensity had no detectable effect upon feeding on yolk. Feeding may continue during stimulation by a direct electric current of sufficient intensity to control the direction of movement of the organism.

The Infusorian can discriminate between and select non-toxic grains of yolk from among toxic ones. "Whether or not it will eat grains that have absorbed a soluble substance depends upon (*a*) the steepness of the effective concentration gradient of the dye, between the grain and the non-toxic medium; and this in turn depends upon the amount of dye absorbed which is subject to a reversible absorption: (*b*) the specific chemical properties (taste?) of the substance absorbed." Different parts of the cell seem to be affected unequally by certain toxic substances. Vacuoles containing indigestible substances are soon extruded, while those containing food are retained; so there appears to be selective extrusion as well as selective ingestion.

Digestion in Bursaria.†—E. J. Lund has studied the processes of digestion and absorption in the food vacuole of this Infusorian, and has

* Journ. Exper. Zool., xvi. (1914) pp. 1–52 (8 figs.).
† Journ. Exper. Zool., xvii. (1914) pp. 1–42 (2 pls. and 8 figs.).

also inquired into the process of extrusion. The liquid of the newly formed food vacuole is partly made up of the external medium and partly of an acid secreted by the base of the buccal pouch. After a few minutes this liquid is absorbed and the vacuole membrane becomes applied to the yolk grain. The vacuole contents remain acid in reaction throughout the process of digestion of vitellin and yolk grains.

Sooner or later after the initial absorption of liquid about a grain, digestion begins. Digestion may or may not result on the second appearance of liquid in the vacuole, according to the principle that whenever the rate of solution—this perhaps in part depending upon the concentration of the cleavage agent—is greater than the rate of absorption, then the liquid products of digestion accumulate more or less about the grain, while if the rate of solution of the grain is slower than the rate of absorption, then the products of digestion are removed as fast as they are formed. Equilibrium between these processes in the vacuole may be established during digestion of vitellin with much, little, or no liquid present in the vacuole.

The average time for complete digestion of vitellin in *Bursaria* was found to be directly proportional to the square root of the quantity of vitelline eaten, i.e. the relation expressed by Arrhenius' formula $t = k\sqrt{M}$ was found to hold to within the limits of experimental error. Congo red absorbed by vitellin grains and ingested by *Bursaria* interferes with or prevents digestion of the parts of the vitellin grain with which the dye is associated and causes an early extrusion. Olein is digested and absorbed by *Bursaria*, while paraffin oil is not affected. Lipoids and fats play an important rôle in promoting growth in *Bursaria*. No evidence was obtained for the formation of stainable lipoid from pure vitellin. There seems to be no digestion of starch or amylum grains.

The time of extrusion is determined by the quality (chemical) and the quantity or intensity (chemical, physical, or both) of the stimulus from within the vacuole by the substance eaten. The maximum tendency to respond by extrusion to the stimulus from the vacuole contents, exists within a limited time (4–6 hours with fresh yolk) after feeding.

Review of Euglenoidina.*—L. B. Walton takes a review of this order of Flagellate Infusorians, with particular reference to the forms found in the city water-supplies and in other localities of Ohio. They are typically elongated ovals or spindles, with a length of 6–500 microns, with a flagellum (or rarely two) arising from a cytopharynx, and consisting of an axial filament in a plasmic sheath They show a rapid rotating swimming movement, drawing themselves forward by means of the flagellum, or a creeping twisting movement. There is a striated periplast, and often a shell besides. A pigment spot or stigma, orange-red or dull yellow, is typically present. There is usually a large vacuole, with a vacuolar canal opening into the reservoir, narrowed anteriorly into a cytopharynx. The large vacuole has opening into it one or more contractile vacuoles. The nucleus consists of a central

* Bull. Ohio State Univ., xix. (1915) pp. 343–449 (15 pls.).

mass surrounded by chromosomes. A blepharoplast is demonstrable, from which the flagellum may arise by two filaments. There are often green chloroleucites. The cytoplasm contains grains of paramylon. Reproduction may occur by asexual vegetative division or by a sexual method, but substantial evidence as to the phases of the latter is still absent. Most species live in fresh-water, a few are marine, and a few are parasitic.

The order is divided into three families: the Englenidæ, which are holophytic, and the Astasiidæ and Paranemidæ, which are saprophytic or saprozoic. Four new species are described, including *Scytomonas dobelli*, from the digestive tract of *Molge vulgaris*, and *Plœotia marina*, a marine form, from Woods Hole. A large number of genera and species are dealt with.

Foraminifera from Australian Coast.* — Frederick Chapman reports on a collection made by the F.I.S. 'Endeavour' from the east coast of Tasmania and off Cape Wiles, South Australia. The list includes over 150 species, some of which are of considerable interest. Figures are given of new varieties of *Spiroloculina dorsata* Reuss, *S. grata* Terquem, *Cornuspira carinata* Costa, and of the species *Marsipella cylindrica* Brady (from 1122 fathoms). *Marginulina costata* Batsch, and *Cristellaria tricarinella* Reuss.

Sporozoa of Spatangoids.†—Helen L. M. Pixell-Goodrich has studied the Sporozoa of *Echinocardium* and *Spatangus*, previously referred to *Lithocystis schneideri* Giard, but including at least five species. Two new ones are described, *L. foliacea* and *L. microspora*. The genus *Urospora* is also represented by *U. neapolitana* sp. n. and *U. echinocardii* sp. n. There is no such species as "*Urospora sænuridis*" which has been ascribed to *Tubifex* by some authors. The so-called "solitary encystment" of *Lithocystis* is not a normal stage, but is the result of necrotic specimens attacked by the phagocytes of the host. In both *Lithocystis* and *Urospora* there is intercalated a stage—prozygote—in which the cytoplasm of the gametes has fused and the tail of the spore has appeared, but the nuclei have not yet combined to form the synkaryon of the true zygote. In *Urospora*, both the "male" gamete and the prozygote are flagellated and motile.

New Acanthosporid Gregarine.‡—Max M. Ellis describes *Prismatospora evansi* g. et sp. n. from nymphs of dragon-flies collected near Douglas Lake, Michigan. The sporocyst is prismatic, composed of a central, regular, hexagonal prism, capped at each end by a regular, truncated, hexagonal pyramid. There are long spines, in two series of six each, inserted symmetrically in the tetrahedral angles at the junctions of the apical pyramids with the central prism. There are no equatorial or polar spines. The epimerite is subglobose with lateral recurved hooks. The new genus stands close to *Cometoides* Labbé.

The parasites occurred in the pre-rectal alimentary canal and could

* Biol. Results 'Endeavour,' iii. (1915) pp. 3–33 (1 pl.).
† Quart. Journ. Micr. Sci., lxi. (1915) pp. 81–104 (1 pl.).
‡ Trans. Amer. Micr. Soc., xxxiii. (1914) pp. 215–22 (7 figs.)

be seen through the transparent ventral wall of the living hosts. They remain in the same place and are attached by crenulations on the margin of the anterior end of the protomerite. These are pushed out like pseudopodia to fit the particular inequalities of the host's alimentary canal. The surface of the ectosarc of a cephalont is thickly covered with papillæ and finger-like processes.

Cutaneous Leishmaniosis.*—W. L. Yakimoff and N. F. Schockov have studied cases of cutaneous leishmaniosis ("bouton d'Orient") in Russian Turkestan, and find that there are two varieties of the parasite (*Leishmania tropica*), differing in size, shape, and plasmic characters.

Sporozoa of Canadian Fishes.†—J. W. Mavor makes a contribution to our scanty knowledge of Myxosporidia in Canadian fishes. His material was obtained from the St. Andrew's region, New Brunswick. He describes *Ceratomyxa acadiensis* sp. n. from the gall-bladder of hake, eel-pout and winter-flounder. In the gall-bladder of the hake (*Urophycis chuss*) it is usually found attached to an undetermined parasite, probably a species of *Myxidium* or *Chloromyxum*, which is itself attached to the gall-bladder. He deals also with *Myxidium bergense* Auerbach, *Goussia gadi* Frebiger, and four other forms.

* C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 107–9.
† Contributions Canadian Biol., Suppl. 47th Rep. Dept. Fisheries, Ottawa, 1915, pp. 25–37 (1 pl. and 6 figs.).

BOTANY.

GENERAL,

Including the Anatomy and Physiology of Seed Plants.

Structure and Development.

Reproductive.

Absorption in Ovules of Scrophularia.*—F. E. Lloyd has studied the rates of absorption in ovules of *Scrophularia* as the result of the injection of stimulatory or other reagents into the living tissues. The author employed two methods of experiment, viz. (1) the injection of 1 to 1000 solution of methylen-blue, and (2) the natural absorption of a weak solution by sections of ovules still attached to the living ovary. The results show that when a reagent such as methylen-blue is passed into the cavity of the ovary, it may reach the egg-apparatus through the funicle, nucellus, and embryo-sac. The walls of the nucellar cells have the power of absorbing methylen-blue owing to some peculiarity of their chemical structure. The innermost layer of the inner integument forms a tapetum, which stains deeply, but is less important than the nucellus in the transfer of the stain ; it is not possible, however, to form any conclusions as to the relative physiological importance of the tapetum. In ovaries that have been injected shortly after pollination, the stain is taken up abundantly by the pollen-tube and passed to the male nuclei and their cytoplasm ; it then penetrates to the egg-apparatus, probably at a much greater rate than the visible accumulation indicates.

Alterations Induced by Treatment of Ovary.†—D. T. MacDougal has studied the aberrant plants produced by seeds from ovaries of *Scrophularia* which had been treated with a dilute solution of potassium iodide. Cultivation of these plants and of a second generation derived from them points to the following conclusions :—1. Injection of the ovary may affect the embryo-sac and pollen-tube either singly or simultaneously, or it may affect the fertilized egg. 2. Any such change of the male or female element would result in the formation of a hybrid by the union of a normal and an altered element : two such hybrids were studied, one of which produced a second generation identical with itself, while the second generation of the other hybrid tended to revert to the parent-type ; in both cases the changes included structure of leaves and stems, colour of flowers, etc. 3. It appears that the changes noted in the hybrid are due to the effect of the reagent either upon the egg-nucleus or on the fertilized egg. 4. The colloidal constituents of

* Year-Book, Carnegie Inst., Washington, xiii. (1914) pp. 77–9 (1 fig.).
† Year-Book, Carnegie Inst., Washington, xiii. (1914) pp. 79–81 (1 fig.).

the living matter are of very unstable character, liable to numerous reactions or transformations, so that some changes may be regarded as loss of character due to the effect of the reagent, while such changes as new incisions in the corolla, etc., are increased differentiations. 5. The changes induced by direct physico-chemical action. 6. Accurate results can only be obtained by the method of injection by studying the course of diffusion of the reagent, time and method of pollination, rate of extension and course of the pollen-tube, and the general structure of the ovule. 7. The germ-plasm of plants appears to have two distinct phases: the one phase in which the meristem splits off into permanent tissues, capable of considerable change by environic forces, but not affecting future generations; and the second phase, during which the chromosomes are reduced and sexual cells are produced, capable of profound change affecting the future of the race.

General.

"Elizabeth-Linnæus Phenomenon." *—F. A. W. Thomas publishes a paper dealing with and explaining "flower-lightning." The author distinguishes between real phenomena due to electrical conditions, and appearances resting solely upon subjective causes. He considers that the so-called "flower lightning," first observed by Elizabeth Linnæus, daughter of the great Swedish botanist, and afterwards described by Goethe and others, must be regarded as belonging to the latter class: it is only perceptible in twilight, and appears to be entirely due to optical illusion. The structure of the outer part of the retina renders it sensitive to different intensities of light, but not to colour: the fovea, i.e. the centre of the yellow spot, on the other hand, is the region of keenest perception of colour; therefore, when in a certain degree of twilight the image of a red flower moves from the peripheral parts of the retina to the fovea, the red colour appears to become more vivid. At the same instant the waves of light approach the length for producing maximum activity in those parts of the retina specially adapted to darkness, so that a distinct reflection of the background of the flower is perceived, and this combines with the more vivid perception of red to give an impression of lightning. This impression is intensified if the fading light is bluish-green in colour.

CRYPTOGAMS.

Pteridophyta.

(By A. Gepp, M.A., F.L.S.)

Branching in the Ophioglossaceæ.†—L. C. Petry has investigated the question of branching in the Ophioglossaceæ. He finds that:—
1. Branching of the rhizome of *Ophioglossum vulgatum* and *O. pendulum* is dichotomous; there are no axillary or adventitious buds on the

* Das Elisabeth Linnè Phenomenon. Jena: G. Fischer, 1914, pp. 1–53 (1 fig.).
† Bot. Gaz., lix. (1915) pp. 345–65 (2 pls. and figs.).

rhizome. 2. Axillary buds are regularly present in five species of *Botrychium*. 3. The vascular connexions of the branches in *Botrychium* vary widely with the species and with the individual specimen. It is concluded that the details of the vascular supply of the branch are controlled by the conditions of development, and are therefore of little or no phylogenetic importance. 4. In wounded rhizomes of *B. obliquum*, renewed activity of the cambium produces considerable masses of accessory xylem; the pith frequently develops sieve tubes and a cambium which produces secondary xylem in quantity; the pericycle often produces sieve tubes and secondary xylem. It is concluded that in this species any stelar tissues capable of growth may produce vascular elements under the influence of an injury. 5 The axillary bud of *B. obliquum* arises as a plate of meristematic cells on the adaxial face of the base of the very young leaf; it develops without differentiation into a plate of meristematic tissue one or two cells in thickness and 50–60 cells in area, which is buried by overgrowth of surrounding tissue. 6. The data secured are in agreement with the evidence pointing to a relationship of the Ophioglossaceæ to the primitive ferns, especially the Zygopterideæ.

Polypodium marginellum and its Allies.*—W. R. Maxon gives an account of *Polypodium marginellum* and its immediate allies, a group of the subgenus *Eupolypodium* which is marked by a general structure which is simple and unusual. The species are all epiphytes of moist mountain forests and are closely similar in general form, having fronds which are narrowly linear, simple, 5–25 cm. long, pinnately veined, and having the margin bordered with a capillary or flattish, lustrous, dark brown or ebeneous band of imperishable sclerotic tissue. This sclerotic band has no connexion with the fibrovascular conducting system, for the veins terminate some distance from the margin. The function of the band apparently is to give strength and rigidity to the fronds. This band structure is not known elsewhere in *Eupolypodium*. The case of *P. gramineum* is different, the dusky border being actually composed of conducting tissue, consisting of a marginal vein which connects the excurrent ends of the branched lateral veins. Outside the marginal vein is a delicate border of greenish tissue (which is not present in the *P. marginellum* group). The author discusses six members of the *P. marginellum* group, five of which are from tropical America and one from St. Helena. Possibly also a "*P. marginellum*," collected in the Canary Islands long ago by von Buch, may belong to the group. *P. Hessii* from Porto Rico, and *P. ebeninum* from St. Helena, are described as new to science. A synoptical key to the species is supplied.

Asiatic Species of Polypodium.†—H. Takeda gives an account of the Chinese, and some other Asiatic, species of the *Pleopeltis* section of the genus *Polypodium*. In Christensen's Index there are about seventy species of *Pleopeltis* alloted to temperate and subtropical Asia. Many of these Takeda has investigated, and he finds that considerable reform

* Bull. Torrey Bot. Club, xlii. (1915) pp. 219–25.
† Notes, Roy. Bot. Gard., Edinburgh, No. 39 (1915) pp. 265–312

in nomenclature and also in our conception of certain species is necessary. Many species have been named over and over again by different, or by the same, botanists. Consequently, about a third of the species have to be reduced; yet a few species, long regarded as synonyms, have to be resuscitated. After criticising the various methods of classification of leading authors, and calling for something more natural, he expresses a belief in such characters as: ramenta on rhizome, position of sori, direction of pinnæ (especially the lowest pair), margin of frond and texture. He gives descriptions of thirty-nine species with varieties, synonyms, etc.

Ferns of the Andes.*—W. R. Maxon, in reporting on a collection of Pteridophytes gathered by J. N. Rose in Peru, Bolivia and Chile, gives a list of twenty-six species, six of which are new to science. He describes the characteristic structure of these, and adds critical notes. The rather high proportion of new species suggests the need of further botanical exploration in the Andes.

Bryophyta.

(By A. Gepp.)

Archegonium of Sphagnum subsecundum.†—G. S. Bryan describes the development of the archegonium of *Sphagnum subsecundum*. In his summary he says that:—1. Sex-organs were produced in vast quantities in the autumn of 1912–13 in an Indiana bog. 2. At maturity the archegonial and antheridial heads are readily distinguished, and the former may be recognized by the coloured bud in the middle. This bud contains terminal archegonia on short side branches. 3. The archegonia begin to develop in September. 4. The apical cell of a side branch is a primordium; each of the two last-formed segments becomes the initial of a secondary archegonium, while that part of the apical cell above, and not included by these segments, is the initial of the primary archegonium. 5. The early stages of development of the primary archegonium show great irregularity; there may be a filament of cells by successive transverse divisions of the apical cell—or growth by an apical cell with two cutting faces—or a mixture of planes. 6. The secondary archegonium develops only by successive transverse divisions. 7. The archegonium proper is initiated in the usual Bryophyte manner. In the terminal cells three oblique walls cut off three peripheral segments and originate the primary axial cell within, which dividing gives rise to cover cell and central cell. The cover cell is relatively inactive and cuts off no basal segments. 9. The central cell on division forms the primary neck canal cell (mother-cell of neck canal row) and the primary ventral cell. 10. The growth of the neck canal row is intercalary, the cells dividing in almost any order. 11. The primary ventral cell divides late into ventral canal cell and egg. 12. The growth of the wall cells of the archegonium is intercalary. 13. The mature archegonium has eight or

* Smithsonian Misc. Coll., lxv. No. 8 (Washington, 1915) 12 pp.

† Bot. Gaz., lix. (1915) pp. 40–56 (4 pls.).

nine canal cells. 14. The breaking down of the canal row may begin at any point, is frequently acropetal, but never involves the ventral canal cell. 15. The ventral canal cell is persistent, behaves for a time exactly as does the egg, but normally disintegrates just before the archegonium opens for fertilization. 16. Abnormalities, such as double venters, multiple eggs, etc., are of common occurrence. 17. The archegonium of *Sphagnum* is synthetic, combining certain characters of the Hepaticæ with those of the Musci.

Plagiochasma.*—A. W. Evans gives an account of the thalloid hepatic genus *Plagiochasma* and of its North American species, a revision of which was badly needed. In an historical introduction the author tells how the generic name was proposed in 1832, and why he prefers this name to the older *Aytonia*, *Rupinia*, etc. He tells also, briefly, when and where the various species have been created, and which species have been shown to be synonyms, the result being that thirty-four species are accepted and four left as doubtful. Passing on to the morphology and anatomical structure of the plant, he describes the thallus, the epidermis and pores, the photosynthetic and ventral tissues, the rhizoids and ventral scales, the male and female inflorescences and reproductive organs, the sporophyte, spores, and elaters. He discusses also the significance of the carpocephalum, and the views of botanists concerning it. He then describes each of the six North American species, giving figures, synonymy, distribution, and critical notes, and he appends a bibliography.

Pedicel of Lunularia vulgaris.†—P. Lesage describes some experiments made upon the hepatic *Lunularia vulgaris*. The pedicel of the female capitulum remains abbreviated until the spores are ripe, whereupon a rapid elongation of the pedicel, to about 25 mm., takes place. The author prevented this normal elongation from being completely carried out by covering the plants down. As a result the pedicel remained more or less dwarfed (say 14 mm.), but the normally short stalks (2·25 mm.) of the sporangia took up the growth and became abnormally long (3·50–4·0 mm.). This means that the stimulus of growth, which normally works itself out upon a part of the oodhyte, passed on to the sporophyte, and stimulated its tissues to an abnormal growth. The author found that the extra growth of the sporangial stalks was in part due to the moist atmosphere caused by covering down the plant, but in part only.

Bryophyta of Denmark.‡—C. Jensen publishes the first part of a flora of the Bryophyta of Denmark and the Färöe Islands, in which he describes the Hepaticales, Anthocerotales, and Sphagnales. After treating of the general structure, classification, conservation, etc., he gives

* Bull. Torrey Bot. Club, xlii. (1915) pp. 259–308 (figs.).
† Comptes Rendus, clx. (1915) pp. 679–81
‡ Danmarks Mosser. I. Köbenhavn: Gyldendalske Boghandel (1915) p. 317 (figs.).

a description of every tribe, genus, species, and variety, with keys and numerous figures. The text is in Danish.

Moss Exchange Club.*—W. Ingham publishes the twentieth annual report of the Moss Exchange Club, containing lists of the mosses and hepatics collected by and distributed among the members. Critical notes on the specimens are appended; also a new key to *Thuidium recognitum* and its allies, by H. N. Dixon, is included.

Thallophyta.

Algæ.

(By Mrs. E. S. Gepp.)

Algæ of Hampstead Heath.†—E. M. Delf reports on the algal vegetation of a series of eight ponds, connected with one another, on Wylde's Farm, Hampstead Heath. A table is given of the species observed in the whole series of ponds, together with the number of occurrences noted between January, 1912, and March, 1914. The author finds that there is a well-marked periodicity in the occurrence of the majority of the algæ in these ponds. The season of greatest diversity and abundance was from February to April or May in the years recorded. This corresponds to a period of variable rainfall, gradually ascending temperatures, increasing light intensity, and of comparatively slight development of animal life. As the temperature rises from May to July the algæ become greatly diminished, and many forms altogether disappear until late in the following October or early November. In 1912 there was a secondary maximum in October and November, falling off again in December and January; but in 1913 there was a slight increase in December, and an apparently stationary condition in January prior to the early vernal maximum (January to March) which followed. The Protococcales and Ulotrichales are dominant somewhat prior to the Conjugatæ and Heterokontæ, the Conjugatæ dominating every other form in April and May. One species of *Spirogyra* is described, which is apparently a summer form.

Algological Notes on the Hohe Tatra.‡—A. Scherffel describes two new forms of already recorded fresh-water algæ, and adds four new Hungarian records in a list of species from the Hohe Tatra.

Algæ Stalactites in Bermuda.§—J. W. Harshberger describes the formation of stalactites in the Devil's Hole, Bermuda, caused by the activity of certain species of algæ in removing CO^2 from the water, and thus bringing about the deposit of the limestone. The species in question are *Chrootheca Ricteriana*, *Gleocapsa æruginosa*, *G. gelatinosa*, *G. quaternata* and *Gleotheca linearis*.

* York: Coultas and Volans, Ltd., 1915, pp. 117–44.
† New Phytologist, xiv. (1915) pp. 63–80 (figs.).
‡ Magyar Bot. Lapok, xiii. (1914) pp. 189–93.
§ Torreya, xiv. (1914) pp. 195–7.

Pylaiella Postelsiæ.*—C. Skottsberg describes a new type in the genus *Pylaiella* which he calls *P. Postelsiæ*, and places it in a new subgenus *Panthocarpus*. The alga in question forms dark brown tufts 5–10 mm. long on the stems and leaves of *Postelsia palmæformis*. The tufts are sometimes very dense and cover only a very small area; sometimes, especially on the stems of the host, they form larger patches of a short velvety indument. They consist of innumerable simple or sparely-branched filaments, monosiphonous while sterile. The basal part is formed by branching densely interwoven filaments, creeping on the surface of the host or penetrating between the cortical cells. In the system of erect filaments there is a distinct difference between long and short branches, and these are described in detail. There is one generation of long and one of short branches, which gives to this alga a very characteristic appearance. No hairs have been found. Only plurilocular sporangia are known. The author discusses the systematic position of *P. Postelsiæ*, which represents a rather primitive type among the Ectocarpaceæ.

Saccorhiza bulbosa.†—C. Sauvageau has made a study of the development and biology of *Saccorhiza bulbosa*, and his paper on the subject is the first complete account that has ever been published of the life-history of a *Laminaria* from germination to the adult plant. Certain authors have studied the germination and concluded that the erect plants arose from some sort of protonema. The author states at once that this is an error, and that no protonema intervenes in the normal plant; the thallus arises direct from the germinating spore. Experiments were carried out in cell-cultures, in glass dishes, and on the sori of the plant itself. All the results agreed. The process of germination of the zoospore is described in detail. Some spores show two red spots and two nuclei, but this is merely the result of incomplete segmentation of the protoplasm and not of conjugation. In some rare cases where growth is slow and weakly, germination of the spore produces a creeping filament which bears one or more upright branches and, at the summit, a small *Laminaria*. The author considers that these abnormal growths have probably given rise to the protonema theory. The different stages of growth of the lamina and the bulbous base are described. The oldest individuals reach their maximum growth (about 3 m. in the Gulf of Gascony) in July. The younger ones continue to grow till towards the end of the summer, when they stop growth, leaving the stipes of the youngest ones very short. Then begins the fructification. Many individuals, however, disappear without fruiting, at any rate on their upright thallus. Since the time of Réaumur (1712) authors have regarded the frilled marginal wings of the stipes as characteristic of *S. bulbosa*, and since Sowerby (1807) these have been regarded as the principal seat of fructification. In the Gulf of Gascony plants the wings are wanting, and the sori are spread over the lamina, less generally on the stipes and never on the margins. This curious variation increases the affinity between *S. bulbosa* and *Phyllaria*. By

* Univ. California Publ. (Bot.) vi. (1915) pp. 153–64 (3 pls.).
† Comptes Rendus, clx. (1915) pp. 445–8.

the middle of October, whatever the age of the individual, the thongs of the lamina are short and much truncated. Then, either the stipes, bearing what remains, are broken off and thrown up on the shore, or the lamina is gradually destroyed right down to the bulb. By the end of the autumn nothing else remains, and by the end of the following March the bulbs, too, have disappeared and the young plantlets are once more developing. Sori occur also on the bulb, arising at or after the disappearance of the upright portion. They spread over the external surface, the papillæ, the haptera, and sometimes over the interior. They remain until the disappearance of the plant. Thus the reproduction is carried on longer by the bulb than by the lamina. Sori from the stipes and lamina collected in October, and sori collected from bulbs in February and March have produced identical plantlets. The zoospores of *Phyllaria reniformis*, another annual *Laminaria*, germinate more rapidly and more uniformly than those of *S. bulbosa*. Monostromatic and polystromatic plantlets, gathered on the rocks by the Banyuls Laboratory, correspond nearly with those of *S. bulbosa* from the Gulf of Gascony.

New Species of Fucus.*—C. Sauvageau describes a new species, *Fucus dichotomus*, found by him at the junction of the oyster beds with the heath at Arcachon. It grows intermingled with *F. platycarpus* and *F. vesiculosus*, and is easily distinguished at the time of summer fructification, when the tufts attain a length of 30 cm. The author attributes the fact of its not having been recognized heretofore to the probability that the conditions necessary to its existence are not often realized. The period of fructification is shorter than that of the other three common European species. In spring no plant shows the least trace of fruiting, the fronds are 5–7 mm. wide, flat or twisted, often 20–25 mm. long. Long hairs issue from the cryptostomata. In July the apices are suddenly changed into receptacles, and each individual often possesses several hundreds. But it is not till the early days of August that the reproductive organs are capable of fertilization; they remain fertile till the end of September or beginning of October. Certain individuals disappear after the summer fructification: others fruit again, thanks to their adventitious shoots. The individuals, of reduced size, which result from the summer germination, fruit in the autumn, then disappear or are maintained by their adventitious shoots. Individuals which germinate in winter, or late in autumn, grow slowly at first: they will fruit in the following summer, either directly or on their adventitious shoots. The receptacles diminish in size and number during the autumn and winter; at the same time the relative number of the antheridia becomes less. *F. dichotomus* is distinguished from *F. platycarpus* by its flabellate branching, by the simultaneous and abundant transformation of the apices into receptacles, and by the cylindrical form of the receptacles. The plant, being fixed, is preserved but not propagated by its adventitious shoots, which enable certain individuals to live for a whole year, or probably even two years. The author discusses the affinity between *F. dichotomus* and *F. lutarius*, and decides that their connexion, if any, was an ancient one.

* Comptes Rendus, clx. (1915) pp. 557–9.

Hybrid Fucus.*—M. Gard describes a hybrid between *Fucus ceranoides* and *F. vesiculosus*, which he found at the entrance of the Hossegor pond at Cap Breton. The hybrid grows among the parent-plants. It has few vesicles, irregularly distributed. The frond is much branched, and the branches form a sort of cyme, as in *F. ceranoides*. The plants are unisexual, one only having proved to be hermaphrodite. The same hybrid has been found at La Tremblade and at Réville, near St. Waast-la-Hougue.

Phytobenthos of Quarnero.†—V. Vouk publishes an algal flora of the Quarnero region, treating of the biological as well as the systematic side. Seven different localities were examined, and the results are given. Dredging was undertaken in a depth of 10–15 m., when certain of the deeper species were obtained.

Japanese Algæ.‡—K. Okamura continues his "Icones of Japanese Algæ." In the present number figures and descriptions are published of nine species, giving the habit and structure of each. Six of these belong to the genus *Codium*, and the rest to *Vidalia*, *Compsopogon*, and *Brachytrichia*.

Chinese Marine Algæ.§—A. D. Cotton publishes a list of thirty-nine marine algæ from Chinese waters, including for geographical reasons the island of Formosa. Some of these were collected by P. H. Boyden at Wei-hai-wei, and others, which are already incorporated in the Kew Herbarium, belong to old collections, and have not hitherto been named or published. Eleven species of *Sargassum* are recorded, and *Ecklonia cava*, which has only been found in Japan. The differences between *Gelidium Amansii* and *G. cartilagineum* (Cape of Good Hope) are pointed out.

Marine Algæ.‖—A. Mazza continues his studies of oceanic algology, and gives an account of the morphology and structure of *Cryptonemia obovata* and of six species of *Thamnoclonium*, two of which live in symbiosis with sponges.

Oxidases in Algæ.¶—G. B. Reed describes his methods for demonstrating the presence of oxidases in the tissues of algæ, and displays his results in the form of a table. The material was placed in a $\frac{1}{2}$ p.c. watery solution of paraphenylenediamine, or in equal parts of $\frac{1}{2}$ p.c. solution of paraphenylenediamine and alpha napthol; and in each case sufficient hydrogen peroxide was added to make the concentration 0·1 p.c. Results were similar in the two cases. In from half to ten minutes the oxidation products appeared in the form of minute dark granules, exhibiting slow Brownian movement and distributed throughout the protoplasm, but never in the vacuole. In *Vaucheria* they tend

* Comptes Rendus, clx. (1915) pp. 323–25.

† Bull. Trav. Sci. Math. Nat. Acad. Sci. et Arts Slaves Sud Zagreb (Agram). 1914, No. 2, pp. 99–117. See also Bot. Centralbl., cxxviii. (1915) p. 138.

‡ Icon. Jap. Algæ, iii. No. 7 (Tokyo, 1915) pp. 123–54 (pls. 131–5).

§ Kew Bull., 1915, pp. 107–13.

‖ La Nuova Notarisia, xxvi. (1915) pp. 49–75.

¶ Bot. Gaz., lix. (1915) pp. 407–9.

to aggregate round the nucleus, but never round the chromatophores. But where the algal cells had been boiled, no granules were formed, since the oxidase ferment had been destroyed by the boiling. It had previously been supposed that the tissues of algæ were free from oxidase owing to the presence of reducing substances. But Reed's results show that oxidases are of general occurrence among the algæ, though the ferment appears to be capable of activating the oxidation of a limited number of compounds.

Fungi.

(By A. Lorrain Smith, F.L.S.)

Oidium on Citrus Trees.*—The fungus in question was found on a Dancy tangerine in an orange grove at Los Angeles, S. California. It was then searched for and ultimately found at several other localities. The leaves only are affected; it begins on their edges when quite young as isolated spots on the upper surface. The greatest number of affected leaves were found on the north and west sides of the tree towards the centre and near the ground. The name *Oidium tingitanium* has been given to the new fungus, of which a full description and diagnosis have been published. Inoculation experiments had only negative results.

Hibernation of Vine Mildew.†—The wintering of this fungus, *Uncinula necator*, is still more or less unexplained, as perithecia (the winter form) seem to be seldom produced. Joseph Ibos has studied the subject and publishes his observations. Perithecia had been discovered by Istvanffi on grapes in 1908. Various districts in Hungary were visited by Ibos in 1913, and leaves were also sent to him in a diseased condition from many sources. He found on minute examination that perithecia were present on many of the mildew patches. The unusual abundance of these was due, he considered, to the climatic conditions of the season: a cool wet summer followed by a dry warm autumn.

Study of Peziza.‡—F. J. Seaver has published photographs and descriptions of some of the large *Pezizæ*, European species that grow also in the United States. The species so examined and described are: *Peziza badia*, on the ground in deciduous woods; *P. vesiculosa*, found on manure piles and rich soil; *P. pustulata*, on charcoal and burnt areas; and *P. sylvestris*, from rubbish heaps and soil in woods. The latter species is almost identical with *P. pustulata* in colour and size, but differs in spore characters.

Australian Cordyceps.§—C. G. Lloyd has published illustrations and descriptions of all the species of this genus recorded from Australasia. All the large species come from Australia, though only six altogether have been found there. Probably many more will be found. These

* Phytopath., v. (1915) pp. 193-6 (1 pl. and 1 fig.).
† Borássati Lapok, xlvi. (Budapest, 1914) pp. 703-4, 712-13, 728-9 (8 figs.). See also Bull. Agric. Intell. Rome, vi. (1915) p. 312.
‡ Mycologia, vii. (1915) pp. 90-3 (2 pls.).
§ Synopsis of the Cordyceps of Australia. Cinn., Ohio (1915) 12 pp. (figs.).

large forms "are all attached to buried larvæ, the club and stem alone appearing above the ground, and they appear like simple Clavarias."

An account of the life-history of the genus is given by Lloyd, with biological and other notes on Australian species.

Notes on Ascomycetes.*—J. Ramsbottom draws attention to the double use of the generic name *Protascus* recently given by Wolk to one of the Protoascineæ which caused "yellow-grains" of rice. The name had already been used by Dangeard for a Chytridiaceous fungus parasitic on Anguillules. Ramsbottom proposes the name *Wolkia* for the "yellow-grain" fungus.

In a second paper he discusses the occurrence and systematic value of guttulæ in the spore of Discomycetes. They are frequently used as characters of diagnostic importance, but though very distinct in fresh specimens when mounted in water, they are dissolved both by tincture of iodine and by alcohol, and they disappear in a night when mounted in glycerin. In herbarium slides mounted in glycerin, all guttulæ have disappeared.

Nuclear Migration in Phragmidium violaceum.†—E. J. Welsford has reinvestigated the formation of the binuclear stage in the æcidium of this species, and her results confirm those already described by V. H. Blackmann. The binucleate condition is brought about by the migration of a vegetative nucleus to a fertile cell, and no other mode of duplication was observed. The size of the pore, through which the nucleus passes, is very small, though sometimes measuring up to 3 μ in width. That these migrations are not pathological in nature is shown by the facts that:—1. They occur in regular sequence from the middle to the periphery of the æcidium. 2. They are not found in the paraphyses at the periphery of the æcidia, where the cells are nearer to the wounded surface. 3. They are found in material fixed in various ways.

Cultures of Uredineæ.‡—J. C. Arthur has continued these cultures undertaken to follow the life-history of the various forms and to determine their relationships. Great reliance is placed on field observations as affording clues to the related host-plants. In this paper are recorded the successful as well as the negative results obtained during the years 1912, 1913, and 1914. The species reported for the first time are: *Uromyces elegans*: æcidiospores from *Trifolium carolinianum* sown on the same host produced teleutospore sori *Puccinia nodosa*: æcidiospores from *Brodiæa pauciflora* also produced teleutospores on the same host. *Puccinia splendens*: teleutospores from *Hymenoclea monogyra* produced pycnidia and æcidia; æcidiospores reproduced uredo- and teleutospores, all on the same host.

Uredineæ.§—F. C. Stewart and W. H. Rankin discuss the overwintering of *Cronartium ribicola* on the currant. The æcidial form,

* Trans. Brit. Mycol. Soc., v. (1915) pp. 143–6.
† Ann. Bot., xxix. (1915) pp. 293–7 (1 pl.).
‡ Mycologia, vii. (1915) p. 61–89.
§ New York Agric. Exper. Stat., Bull. No. 374 (1914) pp. 41–53 (3 pls.). See also Bull. Agric. Intell. Rome, vi. (1915) pp. 468–9.

known as *Peridermium Strobi*, causes blister-rust on various Pines. The disease appeared at Geneva (New York), and, though all the currants were destroyed, it appeared again. Subsequent search led to the discovery of two specimens of *Pinus Strobus* infected with the disease in the near neighbourhood; and it was from this that the disease had spread.

José Florenza y Condal* reports that the rice crops in the right delta of the Ebro were seriously affected by *Puccinia Oryzæ*, and a good part of the crop was destroyed. The attack was favoured by soil fatigue, the high level of the water causing the beginning of asphyxiation, the use of non-sterilized seed, the use of fertilizers containing an excess of nitrogen with a deficiency of phosphates, potash and iron, unfavourable weather conditions and plant crowding. Remedial measures affecting these conditions are recommended.

Smut of Sorghum.†—Alden A. Potter has examined the occurrence of loose kernel smut in America, and has unravelled the confusion existing between it and the "closed" or "covered" species. The latter is *Sphacelotheca Sorghi*: the loose species is *S. cruenta*, and the latter is the American species. The spores of the two species are very much alike, but the membrane covering the "closed" species is much more permanent. The fragility of the *S. cruenta* "membrane" is due not only to its thinness, but also to the more nearly spherical shape of its component cells.

P. B. Pole-Evans ‡ states that *S. Sorghi* is common throughout South Africa as a parasite of Kaffir corn (*Sorghum vulgare*). The corn is attacked when the plants are young, and the fungus remains concealed in the tissues of the host until flowering, when it causes a singular deformation of the ovaries and prevents grain production. Sterilizing the seed-grain is recommended.

Secotium agaricoides.§—Henry S. Conard has published an account of the fungus, which is nearly related to *Agaricus* (*Psalliota*), and not to the Gasteromycetes as has sometimes been supposed. The species resembles a puff-ball in general appearance, but grows on a short stalk which is continued through the body of the fungus as a columella. Detailed descriptions are given of the growth of the fungus, with an account of the histology and cytology. The relationships of *Secotium* are also examined.

Study of Fomes.‖—C. G. Lloyd has published an account of all the known species of *Fomes*. A history of the genus is given, and a description of the structure. The species are classified under seven general divisions, according to colour either of the substance of the plant

* Synd. Rieg Delta Dereeho del Ebro, Tarragona (1914) 32 pp. (figs.). See also Bull. Agric. Intell. Rome, vi. (1915) pp. 469–70.

† Phytopath., v. (1915) pp. 149–54 (2 pls. and 1 fig.).

‡ Agric. Journ. S. Africa, vii. No. 6 (1914), pp. 811–14 (1 pl.). See also Bull. Agric. Intell. Rome, vi. (1915), p. 470

§ Mycologia, vii. (1915) pp. 94–104 (2 pls.).

‖ Synopsis of the Genus *Fomes*. Cinn., Ohio, 1815, pp. 209–88 (41 figs.).

or of the spores. At the end an alphabetical list is given of species that are synonyms, wrong determinations, etc. An index of the species described is also given. Many of the fungi are illustrated by photographs.

Cytology of Fungi.*—J. Ramsbottom has given a long review of the cytological work on fungi published during the year. It is a complete record, as far as possible, in the present upheaval, of a great amount of work. In Phycomycetes the discussion centres round fertilization, especially in *Phytophthora*, and the subsequent behaviour of the oogonia with spore formation, etc. The Discomycetes have been examined—not only the larger forms, but also minute genera such as *Erysiphe*, several forms of Pyrenomycetes such as *Peckiella* (*Hypomyces*), and *Polystigma*. Ustilagineæ and Uredineæ have been extensively investigated during the year, and the results obtained are fully dealt with. Finally, in Basidiomycetes there are papers on the development of the basidia in *Tremella* and *Dacryomyces*, and of the basidia in *Eocronartium*, which much resembles *Typhula muscicola*. A bibliography of all the papers under review is added; there are twenty-one of these, and the author explains that still other papers have been inaccessible "owing to the present discontent."

Fungi in the Nests of Ants.†—J. S. Bayliss Elliott describes fungi found in the nests of two British ants, *Lasius fuliginosus* and *L. umbratus*. The fungi are associated with the black earthy brittle substance known as "carton," which the ants use in constructing their nests. The first to be described, *Cladosporium myrmecophilum*, had been discovered on the Continent and wrongly placed in *Cladotrichum*. The fungus is dark coloured, and conidia on the freshly examined specimens were scarce, probably having been eaten by the ants. Cultures were successfully made and the true mode of fructification observed.

The second species, *Hormiscium pithyophilum* var. *myrmecophilum*, grew on the carton of the nests of *L. umbratus*, and as the mycelium is very dark coloured it gave the carton the characteristic blackish appearance. The species of fungus grows on the leaves of pines, firs and yews, and as the ants in question sometimes make their nests at the roots of decayed conifer trees, etc., the source of infection may have been infected pine-needles. These fungi were found in all the nests examined from whatever locality; no other fungi were found. The author suggests that they were probably weeded out by the ants.

British Mycology.‡—In the recently published Transactions of the British Mycological Society prominence is given to the work of the members at the annual forays in spring and autumn. The spring foray of last year took place at Symonds Yat, Gloucestershire, and many unusual species were collected by the members, several of them new or rare to our Flora. About two hundred species in all were collected.

* Trans. Brit. Mycol. Soc., v. (1915) pp. 85–125.
† Trans. Brit. Mycol. Soc., v. (1915) pp. 138–42 (1 pl.).
‡ Trans. Brit. Mycol. Soc., v. (1915) pp. 1–66.

Those new to Britain are: *Grandia helvetica*, *Peniophora Molleriana*, *Ramularia Anthrisci* and *Stagonospora Luzulæ*.

The autumn foray was held at Doncaster, and though the prolonged drought of the season had been unfavourable to the growth of fungi, a number of new and rare species were discovered. A full list of species collected at both forays is given, as well as of the Mycetozoa, the lists of these latter being supplied by Norman G. Hadden and Gulielma Lister.

The President of the Society, Reginald Buller, delivered an address on the Fungus Lore of the Greeks and Romans, which gives a historical review of all that was written on fungi from the earliest times. The lecturer treats of ancient ideas on Edible and Poisonous Fungi, on Illustrations, on Medicinal Properties, Cultivation of Fungi, etc., and adds a list of species known to the Ancients.

New British Microfungi.*—J. W. Ellis has described a number of Fungi Imperfecti new to Britain, most of them on dead leaves, twigs, etc. *Hendersonia juncina*, a new species, grew on decaying leaves of *Juncus effusus*; the pycnidia are extremely minute, the spores pallid-yellow and 3-septate.

New British Fungi.—E. M. Wakefield † has been making a study of Thelephoraceæ, and she now gives descriptions of fourteen species new to the British Flora. Several of them were found a number of times in widely different localities. Four of the species belong to the genus *Corticium* and six to *Peniophora*.

G. K. Sutherland ‡ gives an account of new marine Pyrenomycetes. They are all parasites on brown seaweeds. Two genera, *Trailia* and *Orcadia*, are new. Careful biological notes are added to the scientific descriptions of the fungi.

A. Lorrain Smith and J. Ramsbottom § publish their usual summary of new species or new to Britain. A large number of genera and species are dealt with, making a very considerable addition to British micro-fungi, and extending to British localities many species hitherto recorded only on the Continent. Many of the new species were collected by W. D. A. Boyd.

Spanish Microfungi.‖—A list of some fungi parasitic on economic plants has been prepared by Romualdo Gonzalez Fragoso. A number of these are rusts belonging to the genera *Uromyces*, *Puccinia*, *Phragmidium*, etc. To these he has added various Fungi Imperfecti, among them a new species, *Septoria Lycii*, on leaves of *Lycium vulgare*, and a new genus, *Septoriopsis*, similar to *Septoria*, but with superficial pycnidia. The species described, *S. Citri*, grows on the skin of the fruits of *Citrus vulgaris*. The other fungi listed are already known to science.

Diseases of Plants.—G. K. Pethybridge ¶ discusses the possible sources of infection for the disease of leaf-spot in celery. The fungus

* Trans. Brit. Mycol. Soc., v. (1915) pp. 135–7.
† Trans. Brit. Mycol. Soc., v. (1915) pp. 126–34.
‡ Trans. Brit. Mycol. Soc., v. (1915) pp. 147–55 (1 pl.).
§ Trans. Brit. Mycol. Soc., v. (1915) pp. 156–68.
‖ Bol. Hist. Nat., xv. (1915) pp. 120–32 (2 figs.).
¶ Journ. Roy. Hort. Soc., xl. (1915) pp. 476–80.

causing the disease is *Septoria Petroselini* var. *Apii*. It has spread very widely in recent years, and caused great loss. It had been already established that the fungus could be carried by the seed, the spores being partially embedded in the pericarp, but Pethybridge considers that it may also be further disseminated by passing on to wild plants. He himself found it on plants of wild celery in W. Galway. Inoculation experiments proved the fungus to be the same as the one on cultivated celery.

J. K. Ramsbottom * has worked out the disease of *Iris*, known as leaf-blotch, which generally appears in August and September, though often present in spring as well. The rhizomes are not directly affected by the disease, but the plants as a whole are seriously weakened, and eventually become exhausted and die.

The fungus causing the disease is a Hyphomycete, *Heterosporium gracile*, which invades the plant tissues; the conidiophores rise in tufts through the stomata of the leaves and bear single conidia at their apices. The conidia, at first colourless, become brownish-olive and septate; they germinate in a few hours, and plants infected produced the diseased spots, and finally conidia, in about six weeks.

C. J. E. Dalmeda † comments on the blackening of cacao-pods in the West Indies. The trouble is due to *Phytophthora faberi*, and the pods are attacked when they are just about to ripen. The disease is most prevalent in the damper districts which are subject to thick fogs, and also during the rainy season. Preventive measures such as spraying with Bordeaux mixture have proved very effective in checking the disease.

Paul A. Van des Bijl ‡ describes the mischief done to apple-tree branches and fruit by the fungus *Coniothecium chomatosporum*. On branches it causes small dark specks which induce blisters in the bark. On the apples it causes "russeting," producing a hardening of the cells, so that when the apple swells cracks are produced in the skin. Pruning and removal of all affected material is recommended, as also spraying with Bordeaux mixture before the trees begin to bud.

Ethel M. Doidge § has described a disease of potatoes in S. Africa due to the fungus *Vermicularia varians*. It has also been found in Australia, where MacAlpine gave it the name "black-dot disease," as suggesting the typical appearance of the diseased tubers. The fungus appears just before flowering, and the stems are then seen to be covered with minute black dots which represent the sclerotia of the fungus, and are developed in the tissue of the epidermis, through which they ultimately burst. The stems attacked lose their fresh green colour, the leaves fall off, and eventually the whole plant becomes brown and dry and quite brittle. If the attack is late in the season, the tubers may not be seriously affected, otherwise their growth is arrested, and they also may be diseased. Burning of all the haulms affected is recommended.

* Journ. Roy. Hort. Soc., xl. (1915) pp. 481–92 (7 pls.).

† Bol. Secr. Agric., ix. (1914) pp. 213–6. See also Bull. Agric. Intell. Rome, vi. (1915) pp. 312–3.

‡ Agric. Journ. South Africa, viii. (1914) pp. 64–7 (figs. 1–6). See also Bull. Agric. Intell. Rome, vi. (1915) p. 313.

§ Agric. Journ. South Africa, vii. (1914) pp. 879–82 (1 pl.). See also Bull. Agric. Intell. Rome, vi. (1915) pp. 470–2.

In the United States * chestnuts have suffered severe damage from *Armillaria mellea*. The effect on the trees is shown in the large number of diseased heads, in the drying of the tips of the branches, and in the ultimate destruction of the trees. The prevalence of *Armillaria* in S. Carolina is one of the factors responsible for the gradual disappearance of the chestnut from that State.

In discussing diseases of potatoes O. Appel † cites several that are due to microfungi. A number of these, termed leaf-roll diseases, he prefers to designate as vascular mycosis, as the vascular tissues are browned by the disease. The fungus causing the disease may be a *Fusarium*, but *Verticillium* also causes a similar disease. Vascular mycosis in America is especially prevalent in irrigated districts.

Other diseases are the "foot-diseases." One of these is caused by *Rhizoctonia*, which attacks seedlings. It also retards growth of older plants, so that the haulms are shorter than usual. In a bad attack the whole shoot dies. As the fungus is in the soil it is not of much avail to sterilize the seed tubers. More study of soil conditions is required. Another disease caused by a fungus, probably *Fusarium*, caused the blackening of the stem. The primary vessels were filled with the hyphæ of the fungus.

E. E. Hubert ‡ found that galls on the twigs of *Populus trichocarpa* were masses of pycnidia of a new *Macrophoma*, which has been named by C. L. Shear *M. tumæfaciens*. A diagnosis of the fungus is given. The galls almost invariably appear "at the point where twigs and branches fork." The twigs and branches are frequently killed by the fungus.

Faith Fyles § publishes an account of the ergot of wild rice (*Zizania aquatica* and *Z. palustris*). Experiments were made by inoculation on a series of grasses other than *Zizania*, with negative results. Further work is promised.

Lichens.

(By A. Lorrain Smith, F.L.S.)

Development of the Ascogonium in Peltigera. ‖ — Fernand Moreau and wife have published an account of their research on the development of the ascogonium in the genus *Peltigera*. It originates from the hyphæ of the medulla at the edge of the fertile lobes of the thallus, and at first consists of hyphæ larger than those of the surrounding tissue, which are at first uninucleate, but by nuclear division become multi-nucleate. At the same time the protoplasm becomes denser and more chromatic. Very soon the cells of the ascogonium send out multi-nucleate ascogonial hyphæ: these branch and cut off at their tips a series of bi-nucleate cells. These terminal cells

* Bull. U.S. Dept. Agric., No. 89 (1914) pp. 1–9 (2 pls.). See also Bull. Agric. Intell. Rome, vi. (1915) p. 472.

† Phytopath., v. (1915) pp. 139–48.

‡ Phytopath., v. (1915) pp. 182–5 (3 figs.).

§ Phytopath. v. (1915) pp. 186–91.

‖ Comptes Rendus, clx. (1915) pp. 526–8.

become transformed into asci, and the two nuclei fuse. The most careful search revealed no other fusion, nor any pairing of nuclei.

The behaviour of the ascus fusion nucleus was also studied; the first mitosis was heterotypic, the second homotypic, and the third typical. Chromatic reduction takes place according to the hetero-homotypic scheme in the two first divisions; the third division is vegetative.

In *Peltigera* there is a special peculiarity in that the nucleolus and nuclear membrane disappear at an early stage. Also in other Ascomycetes, while the haploid number of chromosomes is generally four or eight, they are reduced in the lichen to two. Thus two chromosomes with two branches appear in the prophase of the first mitosis of the ascus; the second mitosis shows two chromosomes which had already divided longitudinally towards the end of the preceding division; in the third mitosis the two chromosomes are simple, and remain so in all succeeding divisions, both of vegetative and ascogonial hyphæ.

The writers conclude that in these lichens there is no fusion of nuclei in the ascogonium; the only karyogamy is that in the ascus, and is immediately followed by a chromatin reduction, which presents the same characters as in other living organisms.

Mycetozoa.

(By A. Lorrain Smith, F.L.S.).

Japanese Mycetozoa.*—Gulielma Lister has received during the last eight years a series of letters and specimens from Kamagusu Minakata, and now records the results of her work on these. Until Minakata began his investigations very little was known of Japanese Mycetozoa; now, thanks to his researches, there are 110 species recorded, three of which are new to science, and much new information has been gleaned as to distribution, variation of species, etc. G. Lister gathers from a comparative study of species found in Britain, in tropical Ceylon and in Japan that the latter country stands midway between the other two in regard to species, though more investigation is needed to decide the question accurately. A descriptive list of Japanese species is given along with quaint notes by Minakata.

Schizophyta.

Schizomycetes.

Protozoa in Relation to the Factor Limiting Bacteriæ Activity in Soil.†—T. Goodey, as the result of experiments conducted with samples of old soils from Broadbalk and Barnfield bottled in 1846 and 1870 respectively, has come to the conclusion that protozoa, including ciliates, amœbæ and flagellates, added to soil are not able to act as a factor limiting bacteriæ activity in soil, and that inferentially such organisms obtainable from ordinary soil under cultural conditions do

* Trans. Brit. Mycol. Soc., v. (1915) pp. 67–84 (1 pl.).
† Proc. Roy. Soc., Series B, lxxxviii. (1915) pp. 437–56.

not function as the limiting factor in the sense in which that term has been used by Russell and Hutchinson; the ciliated protozoa present being probably in an encysted condition. The specimens of 1846 soil did not contain any protozoa, nevertheless a gradual decrease in the number of bacteria present in the soil was observed. On the other hand, in the case of an 1865 (Broadbalk) soil, in which an abundant protozoan fauna of amœbæ and flagellates was present, and presumably active, the numbers of bacteriæ were maintained at a high level. In the latter case partial sterilization is obviously effected without the elimination of protozoa.

Gas Gangrene due to the Vibrion septique.*—B. Weinberg has isolated an organism belonging to the *Bacillus œdematis maligni* (*Vibrion septique*) group from a case of gas gangrene caused by shell wounds. The *Bacillus perfringens* was also present in the wound exudate, and in such cases it is suggested that the injection of a *sérum antivibrion* in addition to a polyvalent antiperfringens serum would be likely to lead to the best results in treatment.

[This association of the two organisms in cases of gas gangrene is in accord with the unpublished observations of workers in this country, who are investigating these conditions.]

Bacillus perfringens and Gas Gangrene.†—A. Orticoni concludes, as the result of his researches on gas gangrene, that in a certain number of wounds contracted in war, complicated by gaseous symptoms, with or without gangrene, the causal organism may be other than the *Bacillus œdematis maligni* (*Vibrion septique* of Pasteur). Foremost among these organisms is the *Bacillus perfringens*, which appears to the author to be the one that is most frequently met with in lesions of these kinds.

The author has also isolated a pyogenic bacillus from one of these cases. The organism was very motile, measured about 0·5 to 0·7 μ, was Gram-negative, and grew rapidly and abundantly on all the ordinary laboratory media, producing a quantity of indole when grown in peptone media. On subcutaneous inoculation in rabbits the organism provoked abscess formation at the seat of inoculation. It does not appear that the bacillus is of any significance in gas gangrene infection.

The Constancy of the Association of B. perfringens and Gas Gangrene.‡—H. L. Reverchon and E. Vaucher confirm the observations of Yamanoushi, Wright, Orticoni, Delage and Prat, by the finding of *B. perfringens* in all cases of shell wounds accompanied by gas gangrene that they have investigated. [Their observations do not, however, exclude the possibility of the presence of other anærobes, such as *Bacillus œdematis maligni*, in the wounds.]

Virulence of Tubercle Bacilli.§—E. Burnet has examined the virulence of different strains of *Bacillus tuberculosis* arising under

* C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 141–3.
† C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 126–8.
‡ C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 146–9.
§ Ann. Inst. Pasteur, xxix. (1915) pp. 221–36.

varying conditions. The bacillus could not be isolated from eighteen samples of desiccated dust obtained from "vacuum cleaners," but virulent bacilli were obtained in three samples out of eighteen of fresh dust. Two of these positive samples were obtained from scrapings from the floors of omnibuses, doubtless contaminated by expectorations.

An attempt was made to simulate the conditions met with in apartments, in order to see what influence, if any, such surroundings had on the virulence of the bacillus. Tubercle bacilli were mixed with sterile powdered dust and placed in a shallow layer in the bottom of a Petri dish, and then exposed to diffuse light. The bacilli retained their virulence for about eight months, and when the virulence was declining, and could only cause a slow tuberculosis in guinea-pigs, virulent bacilli could still be obtained from the lesions of such animals.

Attenuated tubercle bacilli are met with in lupus, but the origin of these strains is uncertain. They probably exist in nature, but have not yet been isolated. Bacilli attenuated for the guinea-pig are not exalted by passage through these animals, though the virulence for the guinea-pig is raised by passage through monkeys (*Rhesus cynocephalus*). X-ray application does not appear to affect the virulence of organisms inoculated subcutaneously into guinea-pigs. The bacilli cultivated at the end of the irradiation showed the same virulence as the organisms used for inoculating.

The Resistance of Fowl to Infection with Spirochæta gallinarum.*—It having been observed that hypertrophy of the thyroid gland and spleen are constantly met with in the course of fowl spirochætosis, L. Launoy and M. Lévy-Bruhl have investigated the rôle played by these organs in infection of the fowl by *Spirochæta gallinarum*. The preliminary removal of the thyroid gland and spleen does not affect the resistance of the adult fowl to spirochætal infection nor the production of a state of immunity. In cases where the spleen has been removed, the septicæmia resulting from infection of the animal is much greater than in the case of a control fowl in which the spleen has not been removed, but, on the other hand, the clinical symptoms of the disease are much less marked and the phenomena of intoxication are almost absent. This apparently paradoxical result is probably due to the fact that normally a considerable number of spirochætes are destroyed in the spleen, and that massive doses of toxic substances are thus liberated, such toxins being responsible for the "andynamic syndrome" so characteristic of infection by the organism in question.

Studies on Bacillus œdematis maligni and Bacillus chauvæi.†—M. Nicolle, E. Césari and Mlle. A. Raphael have conducted a series of experiments with *Bacillus œdematis maligni* and *Bacillus chauvæi* which tend to show that the biochemical reactions of the two organisms are identical. The effects of the soluble toxin, in each case, on guinea-pigs and rabbits, by intravenous or subcutaneous injection, are identical, and

* Ann. Inst. Pasteur, xxix. (1915) pp. 213–20.
† Ann. Inst. Pasteur, xxix. (1915) pp. 165–77

the hæmolytic and hæmoagglutinating action of the toxins against the red cells of the guinea-pig, rabbit, sheep, horse and ox are not to be distinguished.

Active immunity conferred on guinea-pigs against a certain strain of *B. chauræi* ("Jouan") protected the animals against the toxic effects of soluble toxins derived from various strains of *B. chauræi* and *B. œdematis maligni*, and such anti-toxic serum conferred passive immunity against various strains of the two organisms. The serum of animals inoculated with one type of organisms moreover possessed an anti-infectious action against all strains of both organisms used.

Leprosy and Kedrowsky's Bacillus.* —H. Fraser and W. Fletcher, working in the Federated Malay States with leprous tissue derived from a series of fifty-two cases of non-ulcerating, nodular leprosy, are unable to confirm the observations of Kedrowsky and Bayon respectively, with regard to the cultivation of the *Bacillus lepræ* in vitro. The leprous nodules selected were excised with sterile precautions and small pieces inoculated in placental agar, fish medium, or other medium in which *Bacillus lepræ* is said to develop, but in no single instance in which contamination was strictly excluded did any growth arise. In the earlier experiments it was not infrequent to get cultures of contaminating organisms, diphtheroids, streptothrices and the like, but such contaminations were avoidable with an improvement in technique.

Experiments carried out with a culture of Kedrowsky's original organism, and a strain of Kedrowsky's organism supplied by Bayon (claimed to be identical with his own strain) were responsible for certain atypical lesions in the guinea-pig. These lesions differed in no material respect from those obtained by inoculating such animals with cultures of the Timothygrass Bacillus (*B. phlei*), the smegma bacillus or Rabinowitch's butter bacillus. The conclusion is thus arrived at that there is no evidence that the acid-fast bacillus of Kedrowsky and Bayon is, in fact, the leprosy bacillus.

Etiological Factor in Cerebro-spinal Fever.†—R. Donaldson, from a study of the bacteriological findings in a series of cases of cerebro-spinal fever, has come to some very remarkable conclusions with regard to the etiology of this disease.

A great variety of bacterial forms were discerned by him, both from direct examination and from growth on various media, these appearances being characterized as club-shaped, pear-shaped, point-of-exclamation shaped Gram-positive bacilli, small diplo-bacilli—resembling Hoffmann's bacillus—and Gram-positive cocci occurring in pairs or singly with occasional Gram-negative rods and cocci. Some of the forms met with appeared to be identical with the Klebs-Loeffler bacillus.

It is suggested that the causal organism of cerebro-spinal fever is a diphtheroid rod closely related to the Klebs-Loeffler bacillus and exhibiting extreme pleomorphism. The typical form—a Gram-negative

* Lancet (1915) ii. pp. 13–16. † Lancet (1915) i. pp. 1333–7.

coccus—is assumed to be merely a stage in the life-history of the organism. This meningococcal form is not considered to be the one in which the disease is transmitted, the author regarding the diphtheroid form as being the infective agent. [The number of observations on which the author's conclusions are based appears to be very limited. The possibility that he was dealing with mixed organisms and contaminations readily suggests itself.]

Coccobacillus verodunensis.*—A. Besredka describes an organism which occurs in septic wounds. It is an ovoid coccobacillus, resembling the bacillus of plague, is about 2 μ long and 1 μ broad, and in the fresh state is surrounded by a halo. It is motile. It is easily stained, but not by Gram's method. The staining is markedly polar. It grows on the ordinary media, both aerobically and anaerobically. Broth becomes turbid at first, and later a deposit forms. On agar the colonies are round and transparent, much like those of typhoid. Gelatin is not liquefied. Milk is not coagulated. Gas is formed in lactose agar. It is virulent to rabbits and guinea-pigs. By immunising these animals an anti-coccobacillary serum was obtained, and this was found to possess very marked preventive properties.

* C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 288–90.

MICROSCOPY.

A. Instruments, Accessories, etc.*

1 Stands.

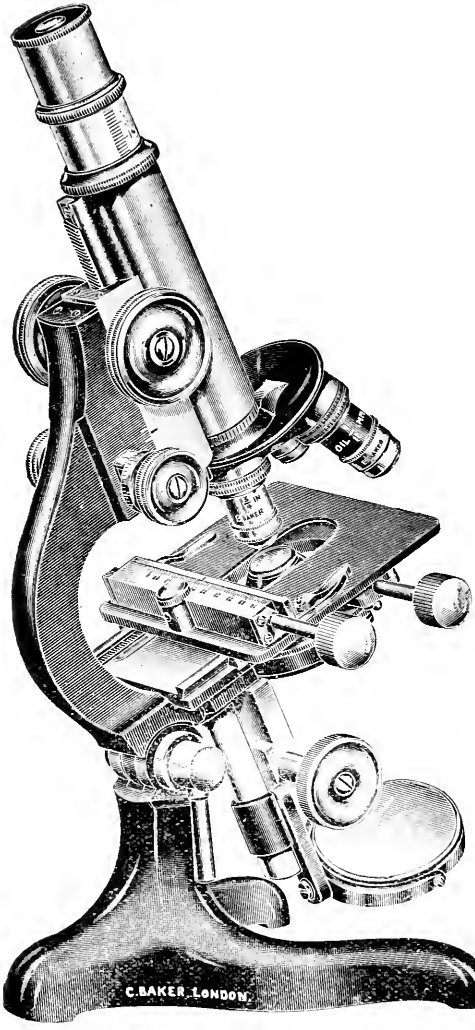


FIG. 49.

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

C. Baker's Stands D A and D.*—These stands (figs. 49 and 50) are copies of well-known Continental models; the former, however, has a

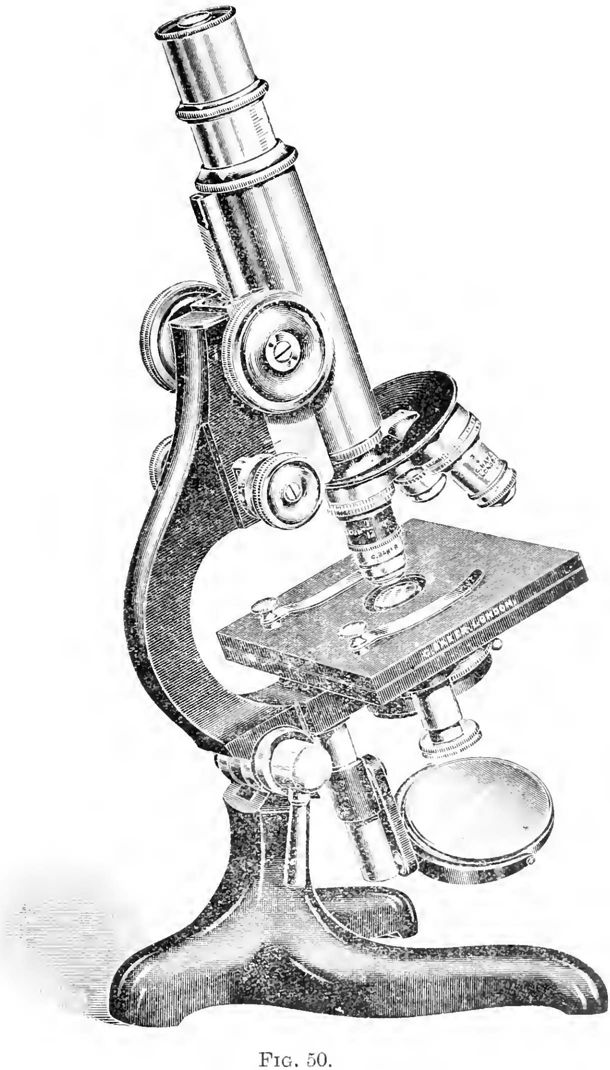


FIG. 50.

built-on mechanical stage, and centring screws to the substage can be provided if required.

* C. Baker's Catalogue, 1915, pp. 12–15.

C. Baker's D.P.H. No. 1a Microscope * (fig. 51) is designed for bacteriological and hæmatological work: it is provided with the usual spiral rack-work coarse-movement and micrometer-screw fine-adjust-

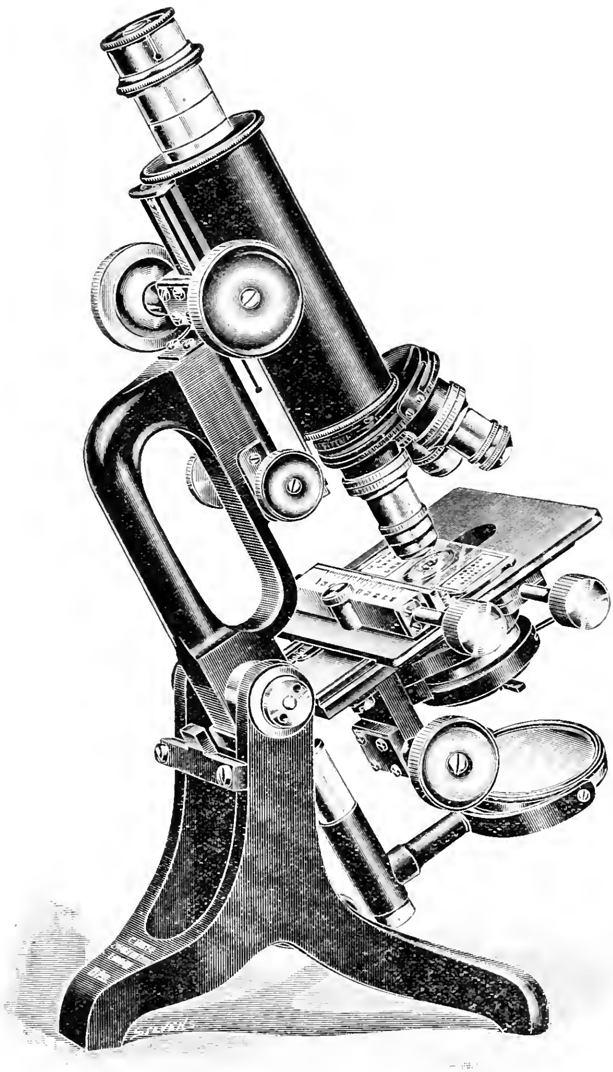


Fig. 51.

* C. Baker's Catalogue, 1915, pp. 10-11.

ment, with milled heads situated either side of the limb. The body is $1\frac{1}{2}$ in. diam., a most useful size when photomicrographs are being made

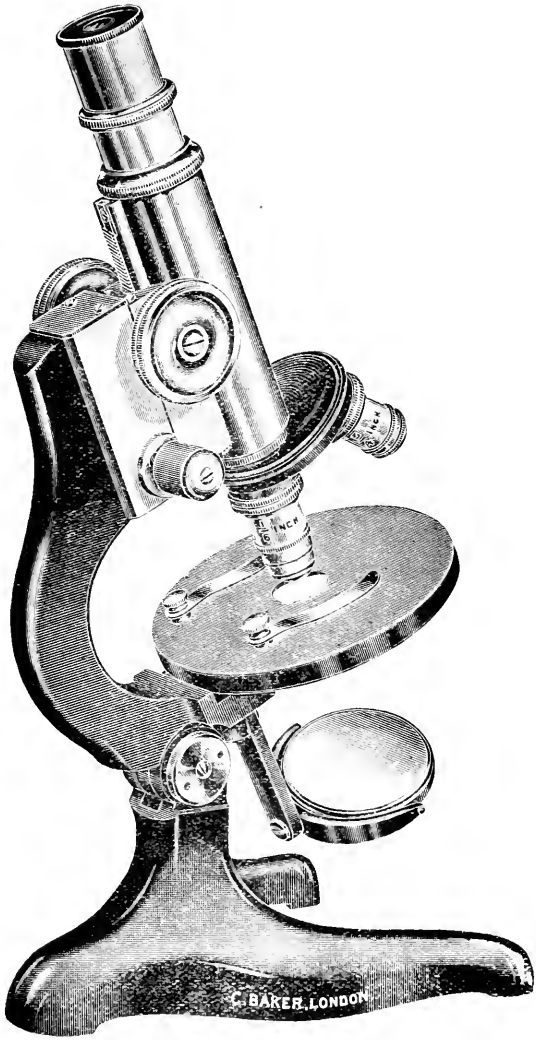


FIG. 52.

with a low-power objective without employing an eye-piece. The draw-tube is arranged to carry eye-pieces of the R.M.S. No. 1 size (23·2 mm.). A built-on mechanical stage, with movements of 30 mm. in a vertical

and 60 mm. in a horizontal direction, is fitted, also rack-work substage, and large plane and concave mirrors.

C. Baker's Student's Microscope* (fig. 52), also on the Continental design, can be provided with either a round or square stage, a sliding substage tube, or a screw-focusing substage capable of being turned aside when not required. This instrument has spiral, rack, coarse, and micrometer-screw fine-adjustments, and is mounted on a steady tripod foot; it is usually supplied with one eye-piece, two objectives, $\frac{2}{3}$ in. and $\frac{1}{6}$ in., and dust-proof double nose-piece. In case, with handle, lock, and key.

(3) Illuminating and other Apparatus.

C. Baker's Electric Lamp† (fig. 53) consists of an incandescent bulb, silvered on the outside except a small window, which is frosted; it is black enamelled, and the brilliant light obtained only proceeds from the

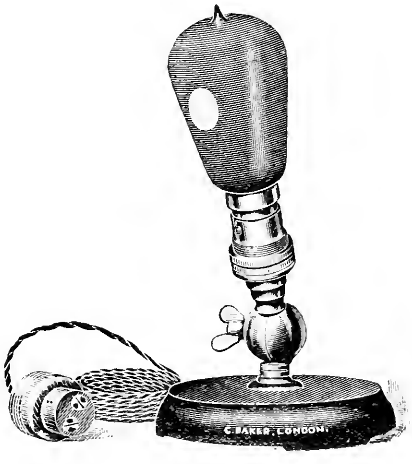


FIG. 53.

frosted window. This forms a very comfortable illuminant to work with, as no stray light affects the user's vision. It is mounted on a heavy stand, with adjustment for inclination.

C. Baker's Portable Battery Lamp ‡ (fig. 54) consists of a small 4-volt bulb in metal cover, with bull's-eye condenser mounted on arm with universal movements, and an upright on circular base, and a two-cell battery. This lamp will burn for twenty hours continuously, and can be readily re-charged without sending to an electrician, at a small cost of sixpence. The light is powerful enough to illuminate a $\frac{1}{12}$-in.

* C. Baker's Catalogue, 1915, pp. 24-5.
† C. Baker's Catalogue, 1915, p. 52.
‡ C. Baker's Catalogue, 1915, p. 53

oil-immersion objective, and is specially recommended for use in the tropics, or where the ordinary electric current is not available.

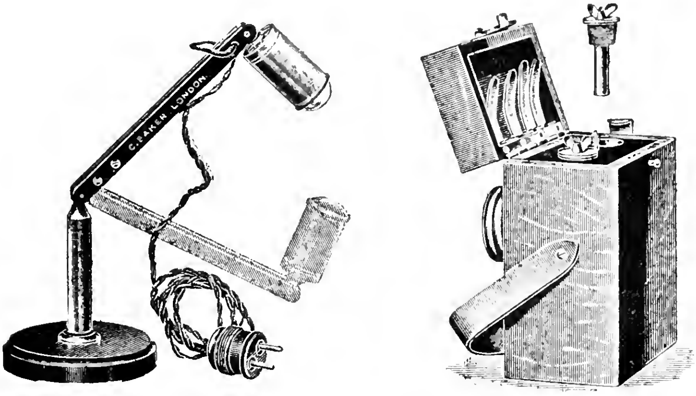


FIG. 54.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

New Method of Sterilizing Bacterial Cultures.† — H. Stassano points out that in sterilizing a broth culture or an emulsion of a bacterium in physiological salt solution, the fluid is subjected to unequal heating, and that in order for the whole of the fluid to attain the indicated lethal temperature the heating must be unnecessarily prolonged. The length of time to ensure sterilization at the given temperature will depend upon (1) the volume of fluid to be sterilized, and (2) the concentration of organisms in suspension. The author has devised a rapid method of sterilization in which the culture or the emulsion traverses, under the constant and regular pressure of an inert gas (e.g. nitrogen), an extremely narrow rectangular cell, formed by the approximation of two flat bronze plates, which are separated by a frame of Japanese paper $\frac{1}{100}$ mm. in thickness, the frame and opposed plates being held together by screws. The apparatus is immersed in a double-boiler at the required temperature, and the fluid, the sterilization of which is desired, is slowly forced through the cell by the pressure of the inert gas. By this means a constantly changing film of the liquid, $\frac{1}{100}$ mm. in thickness, is brought into contact with the bronze plates, which remain constantly at the required temperature.

This method of sterilization is particularly recommended in the preparation of vaccines, as the least amount of injury to the contained antigen, consistent with sterilization, is claimed to be obtained. The

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Embedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, etc.; (6) Miscellaneous.

† Comptes Rendus, clx. (1915) pp. 820–2.

method is also of use in the sterilization or pasteurization of different organic liquids (e.g. milk), as no appreciable modification in their characters and constituents is brought about.

Thyroid and Supra-renal Glands as Bacterial Culture Media.* C. J. Parhon and E. Savini have attempted to grow various organisms, *Bacillus anthracis*, *B. tuberculosis*, etc., on sterile thyroid gland substance. The organ is cut in half-cylindrical pieces, which are placed in the kind of test-tubes that are used for potato cultures. In growing the tubercle bacillus it is necessary to impregnate the piece of tissue for some hours with glycerinated (6 p.c.) physiological salt solution.

On thyroid medium the anthrax bacillus grows quickly, but does not form tangled filaments, as upon ordinary media. It shows a manifest tendency to isolated growth, such growth appearing in L-, V-, U-, or O-shaped forms. The medium has a pronounced bactericidal action, numbers of the bacilli soon dying off, the number of survivors being extremely reduced. Sporulation is delayed.

The tubercle bacillus (human, bovine, or avian) cannot grow on glycerinated thyroid gland, even after a stay of three or four weeks in the incubator. The conclusion is arrived at that the thyroid gland exerts an obvious action on the growth and vitality of the anthrax and tubercle bacillus, and plays an important part in the complex mechanism of immunity.

Anthrax also grows well on supra-renal gland tissue, giving a shining thick growth of a *café-au-lait* colour, which soon changes to chestnut. Sometimes the colour of the culture is grey-violet. The bacilli exhibit marked pleomorphism on this medium, and many dead individuals can be discerned. The tubercle bacillus grows slowly and with difficulty on glycerinated supra-renal gland. After several weeks a scanty growth appears, the best development being with the avian type of the bacillus. Microscopically, the bacilli are much altered, the interior of the organisms containing one or many strongly-staining granules, which sometimes show a bi-polar arrangement.

(4) Staining and Injecting.

Vital-staining with the Free Base of Neutral Red.†—A. M. Przesmycki has employed the free base of neutral red in the vital-staining of the nucleus of certain Infusorian parasites, such as *Opalina ranarum*, *Balantidium entozoon*, and *Nyctotherus cordiformis*, and finds that this stain is much more rapid in its action than neutral red itself. The free base is prepared as follows: to an aqueous solution of neutral red (monochlorhydrate) is added ammonium hydrate until the commencement of the formation of an orange-yellow flocculent precipitate. The chloride of ammonia and ammonia in excess are eliminated by filtration and washing in distilled water. The free base is left behind on the filter-paper in orange-yellow crystals, which are then dried at 80–100° C. On drying, the crystals assume a deeper colour, which is described as being between orange-red and blood-red.

* C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 161–3 and 163–5.
† C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 169–71.

Metallography, etc.

Structure of Electrolytically-deposited Copper.* — A. Sieverts and W. Wippelmann describe the microstructure of copper deposited on iron cathodes, in sheets 0·1–0·3 mm. thick, under different conditions of concentration, acidity, and current density. The deposited sheets, which usually separated readily from the cathode, were clamped between pieces of pure copper, sawn through, and deeply etched on the transverse section, without polishing. A finely-crystalline deposit is first obtained from an acid solution of copper-sulphate. V-shaped crystallites then grow outwards; their size at first diminishes with increasing current density, but increases after a certain limit is exceeded. Deposits obtained from neutral sulphate solutions contain cuprous-oxide particles enclosed between the crystallites. Deposits from alkaline solutions of complex copper salts adhere firmly to the cathode, and are apparently structureless.

Critical Point at 460 C. in Zinc-copper Alloys.†—O. F. Hudson has made a number of experiments to determine whether the thermal change occurring at 460° C. in copper-zinc alloys containing 63 to 40 p.c. of copper is, as Carpenter holds, a eutectoid inversion of β into $\alpha + \gamma$, or is a polymorphic change of β into β_1. The effects of long annealings (for periods up to eleven weeks) at temperatures below the critical point, were that (1) in alloys slightly on the α side of pure β a very decided increase in the amount of α was observed, after a few hours' annealing: subsequently no further increase in the amount of α was noted; (2) pure β showed no sign whatever of breaking down; (3) in alloys slightly on the γ side of pure β there appeared to be a small increase, which soon ceased, in the amount of γ. An inhomogeneous alloy was made by pouring a molten alloy (γ), containing 40 p.c. copper and 60 p.c. zinc, on to copper which had just solidified in a crucible. When cold, the specimen was cut through, and was found to consist of copper at the bottom and γ at the top, with layers of intermediate composition between. The layer of pure β, with some B + γ on one side, and some $\alpha + \beta$ on the other side, was cut out and annealed at 435° C. The β layer gradually grew at the expense of the α and γ, and in thirty-two days increased in width from 0·05–0·075 in. During this experiment recrystallization of the β, by the division of large crystals and the subsequent growth of the small ones formed, was observed. A small piece of copper was immersed in molten zinc at a temperature below 450° C. for thirty-six hours. The whole was allowed to cool, and a section was cut and examined. The copper core was surrounded by a layer of yellow alloy, which in turn was surrounded by a layer of γ. It appeared that the yellow alloy, which was sharply separated from the copper, was β. To test this, the experiment was re-

* Zeitschr. Anorg. Chem., xci. (1915) pp. 1-45.
† Journ. Inst. Metals, xii. (1914, 2) pp. 89 110 (27 figs.).

peated, using α-brass (70–30) in zinc, instead of copper in zinc. After fifty-six hours' annealing, at a temperature not exceeding 450° C., a layer of β was found to have been formed between and sharply divided from the α and γ. Further repetitions of the experiment, using annealing temperatures from 400° C. upwards, gave a layer of β in every case.

The failure to obtain any evidence of the breaking down of β into α and γ, and the clear proofs that stable β (or β_1) may be formed from copper and zinc or from other phases, at temperatures well below the critical point at 460° C., demonstrate that the 460° C. change is not a eutectoid point, but is a polymorphic change occurring in the β-phase, and that β_1 is a stable phase below 460° C.

Bismuth-cadmium Alloys.* — G. J. Petrenko and A. S. Fedorow find that bismuth and cadmium form a simple eutectiferous series of alloys, the solid solubility of bismuth in cadmium, and of cadmium in bismuth, being very slight, probably less than 0·1 p.c. The microscopic examination of the alloys at each end of the series may give misleading results, owing to the effects of segregation. The eutectic segregates to the upper part of the ingot in the bismuth-rich alloys, and to the lower part in the cadmium-rich alloys; in each case regions free from eutectic may be found, consisting of homogeneous crystals, which may be mistaken for homogeneous solid solutions.

Bismuth-arsenic Alloys.†—W. Heike describes the microstructure of alloys containing 5 to 80 p.c. arsenic. Bismuth and arsenic are mutually miscible in the liquid state. Arsenic separates primarily on cooling, and approximately pure bismuth crystallizes last. The sections were etched with dilute copper-ammonium-chloride solution, which coloured the bismuth a reddish brown, the arsenic remaining bright.

Manganese-carbon, Nickel-carbon, Iron-carbon, and Cobalt-carbon Systems.‡—O. Ruff, W. Bormann, and F. Keilig have studied the equilibrium diagrams of these binary systems at temperatures up to 2700° C., and incidentally describe the structure of some of the alloys obtained. The cobalt-carbon alloys, containing up to 11·5 p.c. carbon, showed graphite lamellæ embedded in cobalt. The cobalt-carbide, stable at high temperatures, decomposed into cobalt and graphite on cooling.

Malleable Castings.§ — W. H. Hatfield discusses the modifications in structure brought about by the annealing process in the manufacture of malleable cast iron, and describes the microstructure of foundry cast iron, Swedish white iron, and malleable cast iron made by the Reamur and by the black-heart processes.

Reduced Metals in Crystallized Form.‖—J. H. Bowman describes a method of reducing metals in crystallized form on glass slips as per-

* Int. Zeitschr. Metallog., vi. (1914) pp. 212–16 (1 fig.).
† Int. Zeitschr. Metallog., vi. (1914) pp. 209–11 (3 figs.).
‡ Zeitschr. Anorg. Chem., lxxxviii. (1914) pp. 365–423 (13 figs.).
§ Foundry Trade Journal, xvii. (1915) pp. 248–52 (7 figs.).
‖ Journ. Amer. Chem. Soc., xxxvii. (1915) pp. 1468–71 (6 figs.).

manent Microscope mounts. The process is applicable to such metals as are reducible from solution by some other metal. For the preparation of silver crystals, a small drop of a mixture of equal parts of a 10 p.c. solution of silver nitrate, and a concentrated solution of zinc nitrate, is placed on a glass slip and spread into a thin film. A piece of zinc is filed in such manner that the filings fall thinly over the moist surface. Reduction begins at once, and each zinc particle becomes a centre of crystallization of silver. The preparation is kept in a moist atmosphere until crystallization is complete, then allowed to become nearly dry in the air, coated with balsam in xylol, dried in a dust-free atmosphere, and covered in the usual way. With variations in manipulation, the general process may be used for gold, copper, lead, bismuth, tin, cadmium, and antimony.

Photomicrographs indicate the appearance of the radiating, fern-like crystals produced.

Artificial Sillimanite.* — W. Eitel has examined, microscopically and otherwise, the slags obtained by the ignition of a mixture of iron-thermit and silica. Such slags, which are crystalline, not vitreous, consist essentially of silica and alumina, and contain crystals of the silicate of alumina, sillimanite, strongly resembling the natural mineral. The fibrous structure of the slag was due to the presence of long, very thin, fibre-shaped crystals of sillimanite, but other forms occurred also. Crystals of corundum were abundant in the slags.

Metal-microscopy with Polarized Light.†—H. Hanemann has introduced into the apparatus, previously described, modifications which greatly facilitate the observations. The examination of metallic surfaces by means of reflected polarized light yields information upon the optical properties of the various constituents. The examination of the constituents of numerous iron-carbon alloys indicated that ferrite and austenite were isotropic, martensite was feebly anisotropic, and cementite was anisotropic. Austenite and martensite were thus shown to be distinct phases.

* Zeitschr. Anorg. Chem., lxxxviii. (1914) pp. 173–84 (8 figs.)
† Zeitschr. Anorg. Chem., lxxxviii. (1914) pp. 265–8.

PROCEEDINGS OF THE SOCIETY.

MEETING

Held on the 16th of June, 1915, at 20 Hanover Square, W., Mr. D. J. Scourfield, F.Z.S., Vice-President, in the Chair.

The Minutes of the Meeting of May 19, 1915, were read and confirmed, and signed by the Chairman.

The Chairman mentioned that the visit on June 5 to the John Innes Horticultural Institution, Merton, announced at the last Meeting, had proved thoroughly enjoyable, and that a great deal had been learnt in regard to the extremely important work on questions of heredity which is being carried on there. He was sure the Meeting would approve of a cordial vote of thanks being conveyed to Professor Bateson for his great kindness in explaining everything, and in showing the party over the grounds and laboratories of the Institution.

The Chairman, in announcing that Sir Frank Crisp had presented to the Society the Report of the British Association for 1914, proposed a hearty vote of thanks to Sir Frank Crisp for his very useful contribution to the Library of the Society, which was carried unanimously.

Mr. Frederick Enock, F.L.S. F.E.S., etc., delivered a lecture on "The British Trap-door Spiders," giving at the same time a lantern demonstration on the life and habits of these animals.

At the conclusion of the lecture the Chairman, in proposing a hearty vote of thanks to Mr. Enock, said he was sure the Meeting had listened with the greatest pleasure to the highly interesting account of the British Trap-door Spiders. He wished to mention that during the progress of the Meeting a telegram had been received from the operator who had undertaken to work the lantern, regretting his inability to attend, and he wished to apologise to Mr. Enock for any deficiences which had occurred in the exhibition of his very beautiful slides owing to the usual operator's non-arrival. He was sure the Meeting would agree with him in saying that a most delightful lecture had been delivered by Mr. Enock, whose enthusiasm could not help but prove contagious to his listeners. The vote of thanks was then carried with acclamation by the Meeting.

It was announced that the next Ordinary Meeting would be held on Wednesday, October 20.

It was further announced that the Society's Rooms would be closed from Friday evening, August 20, to Monday morning, September 13.

New Fellow.—The following was elected an *Ordinary* Fellow of the Society :—Alfred J. Attridge.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JOURNAL

OF THE

ROYAL MICROSCOPICAL SOCIETY.

OCTOBER, 1915.

TRANSACTIONS OF THE SOCIETY.

VII.—*On the Male Genital Armature of the Dermaptera. Part I.: Protodermaptera (except Psalidæ).*

By Malcom Burr, M.A. D.Sc. F.L.S. F.E.S.

Communicated by John Hopkinson, V.-P. R.M.S. (*Read May* 19, 1915.)

Plates V. to IX. and Figs. 55 to 57.

The appearance of a paper by H. W. Verhoeff in 1902, under the title "Ueber Dermapteren. I. Aufsatz. Versuch eines neuen, naturlichen Systems auf vergleichend-morphologischer Grundlage und ueber den Microthorax der Insekten," in Zool. Anzeig., did not arouse very immediate, nor wide-spread, attention among the

EXPLANATION OF PLATE V.

FIG.
1. *Diplatys lefroyi* Burr.
2. *D. gladiator* Burr.
3. *D. bormansi* Burr.
4. *D. liberatus* Burr.
5. *D. rufescens* Kirby.
6. *D. gerstæckeri* Dohrn.
7. *D. riggenbachi* Burr.
8. *D. raffrayi* Borm.
9. *D. macrocephalus* Pal.-Beauv. (?).
10. (?)*
11. *D. conradti* Burr (nec Zacher).
12. *Diplatys* sp. n. (*conradti* Zacher, nec Burr).
13. *D. æthiops* Zacher (nec Burr = *conradti* Burr. After Zacher).
14. *D. macrocephalus* Zacher (nec Pal.-Beauv.). After Zacher.
15. *Diplatys conradti* Zacher (nec Burr). After Zacher.
16. *D. vosseleri* Burr. After Zacher.
17. *Nannopygia picta* Zacher. After Zacher.
18. *Karschiella camerunensis* Verh. After Zacher.
19. *K. büttneri* Verh. After Zacher.
20. *K. neavei* Burr.
21. Ditto.
22. *Bormansia africana* Verh. After Zacher.
23. *B. impressicollis* Verh. After Zacher.
24. *Pygidicrana V-nigrum* Serv. After Zacher.
25. *P. fiebrigi* Burr. After Zacher.

* I very much regret that I am unable to identify this figure: there has been a *lapsus calami* in the MS.; the original material is warehoused and inaccessible; the proofs I received travelling in Russia, and so had no means of verifying doubtful points. This must be accepted as an excuse for any inconsistencies which may have crept into the article; the figure will be identified and discussed at a suitable occasion in a later paper.—M. B.

limited number of entomologists who took any interest in the question of the classification of the Dermaptera. The reason is not far to seek: the entire absence of figures, the employment of a number of new characters under new and unfamiliar names, which are nowhere explained, the author's ignorance of the literature of the subject, and the rather obscure language which he employed, together with the fact that he rendered untenable the old make-shift system, which was only accepted by serious students as a temporary convenience, but failed to set up a new one in its place.

The consequence is that most students of the Dermaptera treated Verhoeff's work with a neglect that it did not deserve, entirely through inability to understand it. I was myself profoundly discouraged when I found that he had erected a new genus, *Nesogastrella*, the only character of which was the pin-hole through the elytra! I saw his type afterwards in Berlin; it had been carded, but the big hole made by a common pin was very evident. The specimen was nothing more nor less than a female of the very common *Nesogaster amoenus* Stål. Such errors, and the blunder in the use of the name *Gonolabis*, "Burr et mihi,"' which I have exposed elsewhere, led one to suppose that the whole work was of the same quality, and by common accord Verhoeff was quietly neglected.

But the virtue in his work was at length proclaimed by his keen countryman, Dr. Friedrich Zacher. Thanks to the free access to Verhoeff's types and microscope slides, which were often in very poor condition, Zacher was able to understand what Verhoeff meant, so that he realized the great importance of his compatriot's work; at the same time, being a modern recruit to the subject himself, he was not so likely to have his vision biassed by the *Nesogastrella* and *Gonolabis* blunders. Zacher quite justifiably calls Verhoeff's work "bahnbrechend"; it has broken new ground, and pointed out the new method.

Verhoeff's work suffered from being premature, for the amount of material available was then small. In 1911 Zacher brought out the next step, "Studien über das System der Protodermapteren," * a very important paper, explaining Verhoeff's work, carrying it a good step farther, and above all illustrating it with a large number of figures. Zacher's work has a double virtue; it not only has its own inherent goodness—that is, the actual original observations—but it is a key to Verhoeff, rendering his crabbed words intelligible.

For want of material Zacher was unable to do more than sketch out a system in parts; he has since supplemented the original paper, and Borelli has added descriptions of the genitalia

* Zool. Jahrb., xxx. Heft 4 (1911).

in a few Neotropical forms. But nothing in a comprehensive way has been done since the appearance of Zacher's work.

Although we differed on a number of points of detail, Zacher and I soon found that, though travelling by different roads, we were converging towards a common result. I had previously confined my attention to purely external morphological characters, but now set to work to make a comparative examination of the male genital armature of as great a variety of species, and of genera, as possible.

I am consequently able to supplement Zacher's work very largely, and to confirm or modify his opinions. The accumulation of a much richer material than either Verhoeff or Zacher ever had at their disposal, the preparation, study, illustration, and comparison, has taken a great deal of time, and as in the future I dare not hope to have much time at my disposal, I venture to publish these notes, incomplete as they are, in the hope that they will stimulate other workers to enter the field, and carry on the progress. The classification of the *Psalinæ* in particular requires much study.

It is with the object of drawing the genitalia that I have in recent years impressed on my correspondents abroad the desirability of preserving and packing their specimens in spirit; it is very important that spirit specimens should be kept in as great variety as possible, for we are yet very far from the ideal of possessing a good and careful drawing and description of the genital armature of every known species of earwig.

I am very much indebted to Lt.-Col. F. W. Winn Sampson for the preparation of the slides, work which demands both skill and time, neither of which I was in a position to employ myself. From these slides I have made the drawings which illustrate this paper; they are I fear, very amateurish, and not uniform, but they have the advantage of throwing into relief the points which I wish to emphasize. There is great scope for investigation in the structure of some of these complex organs; I have begun, and hope one day to be allowed to finish, a series of observations on the genitalia of *Diplatys* under very great magnification, with the help and advice of a trained histologist. But for the ordinary purposes of the systematist, an ordinary microscope with 1-in. objective for general examination, and $\frac{1}{4}$-in for details, is quite sufficient.

There is no difficulty in drawing out the genitals from a fresh or spirit-preserved earwig; if the large ninth sternite, or penultimate ventral segment, be lifted, the parameres may be seen resting in a little hollow, from which they may be drawn out with a fine pair of forceps, and transferred to a small tube to await their turn for staining, or they may be simply mounted at once in balsam.

But in dealing with old and dried specimens, the difficulty is greater. I find the simplest method is to break off the last two or three segments of the abdomen, preferably only the last two; this

can easily be done, though it takes a certain knack to break off only the required parts, which is desirable, as if other segments come off, the repairing is extremely difficult. The detached portion should then be boiled gently in caustic potash, the genitals withdrawn and washed, and the two segments placed back in position and cemented. It is well to label such an individual, as if the repairing is well done, one may attempt to repeat the process at a later date upon an already castrated specimen. These old specimens are never so satisfactery as fresh or as spirit-preserved ones, since the delicate structures within the præputial sacs are always obscured; but at all events, the outlines of the metaparameres can be seen clearly, and this is a very important point.

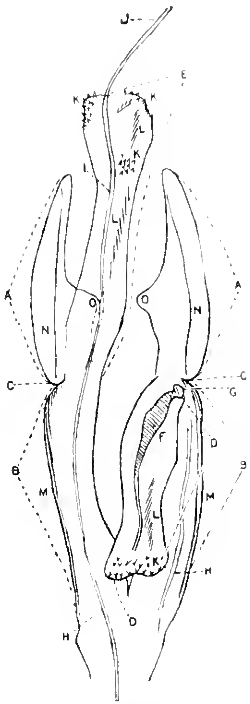


FIG. 55.—PROTODERMAPTEROUS TYPE.

A. Metaparameres.
B. Proparameres. C. Hinge.
D. Præputial sac in repose.
E. Ditto, in erection.
F. Virga, with spiral structure (Allostethine type.)
G. Basal vesicle of virga (Echinosomatine type).
H. Ejaculatory ducts (indistinct).
I. Simple form of virga.
J. Projecting whip-like end of virga in erection.
K. Pads of denticulations.
L. Chitinous thickenings.
M. Strongly chitinized external margin of proparameres.
N. Midrib of metaparameres (Psalid type).
O. Internal tooth of metaparameres.

The male reproductive apparatus of earwigs consists of a pair of chitinous segments, the parameres, which are attached to a fibrous muscular base, the first segment, or proparameres, usually simple long and narrow plates, strongly chitinized in the external margin only; the apical segments or metaparameres offer an extraordinary diversity of size and shape, and are of great systematic value. Sometimes there is a small accessory lobe, or epimerit, at the apex of the metaparameres.

The metaparameres are attached by a distinct hinge to the parameres in most Protodermaptera, but are almost fused into one in the *Echinosomatinæ* and in the Eudermaptera, where the proparameres are degenerate. The former act as grips, for locking the organs to the female *in copula*. Attached to the parameres

are the præputial sacs, or penis proper. There are a pair of these in the Protodermaptera, though one is aborted in the *Hemimerina*, *Arixenia* and *Karschiellinæ*, but only one in the higher Eudermaptera. Within the præputial sacs is a tube called the virga, a portion of the ejaculatory duct, which also offers a great diversity of form and affords highly valuable characters. The virga may be a simple tube, a mere extension of the ejaculatory duct; in many groups it is protected, especially near the base, by a fine spiral binding, the "spiralversteifung" of Zacher, which is especially noticeable in the inflated basal vesicle seen in many groups. In the *Labidurinæ*, the virga is undulated and serpentine; the length of the virga and form and armature of the basal vesicle offers useful specific characters, especially in the *Forficulidæ*. The præputial sac is frequently furnished with chitinous plates or disks, and sometimes with a series of minute teeth. In order to detect the latter, and generally to examine the virga, it is necessary to use a high power of magnification, and often a careful manipulation of light, as the virga and the armature of the præputial sacs are often faint and difficult to extinguish.

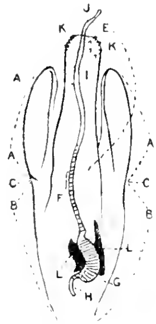


FIG. 56.—EUDERMAPTEROUS TYPE.

A. Metaparameres.
B. Proparameres. C. Hinge.
E. Præputial sac in erection.
F. Virga (with spiral structure).
G. Reniform or basal vesicle of virga.
H. Ejacu atory duct.
I. Simple virga.
J. Protruded end of virga.
K. Denticulations.
L. Chitinous armature of basal or reniform vesicle.

While, I think, everyone will agree that Zacher overrated the value of the genitalia, yet they undoubtedly afford extremely useful generic and specific characters. In the lower earwigs we find a considerable complexity of armature, the genitalia becoming simpler and simpler till we meet a general uniformity in the highest groups.

Probably their study will enable us to define species in such a group as the *Echinosomatinæ*, where mere differences of colour are still used as specific characters; and in the *Psalidæ*, where there is a great uniformity of external features; the study of these organs may enable us to demarcate the genera.

As far as we can yet see, it looks as though the genera based upon these characters may coincide with geographical groups. In the *Pygidicranidæ*, we find the Ethiopian genus *Dicrana* sharply distinguished by the structure of the genitalia from its Neotropical, Oriental, and Australian relatives—that is to say, the type of

metaparameres characteristic of *Dicrana*, and no other genus, occurs only in Africa.

Without any desire to underrate the great value of his work, I certainly think that Zacher overrates the importance of the armature of the præputial sac, and I feel quite unable to grant generic value to the rows of teeth, often very difficult to observe, and so perhaps sometimes overlooked, and chitin pads and plates in the præputial sac. I also consider the virga to afford specific rather than generic characters, for we find great diversity in the length of this organ in species that are undoubtedly closely related, and, in my opinion, congeneric.

In dealing with old and dry specimens, the virga is often difficult or impossible to distinguish; it may be shrivelled away, or dissolved out by the action of the potash. I certainly think that no definite negative opinion on the virga should be formed till several specimens have been examined, as its visibility differs very much in different mounts.

I consider that the most important family characters are afforded by the metaparameres; here we find a grouping into kindred forms that often corresponds well enough with the geographical distribution. But these are after all only secondary sexual characters, analogous to the forceps; and just as we find considerable plasticity in the latter, so we must not be surprised if we find it also in the former. I think we are in the presence of dimorphism in the cases of *Euborellia sisera* Burr and *E. greeni* (see Part II.), where two individuals, externally indistinguishable, often have quite difficult metaparameres.

I am not alone in my opinion that Zacher overrates the value of the genital armature for generic characters. It is no breach of confidence to quote the words of so eminent an entomologist as my old friend Dr. H. A. Krauss: "Ich freue mich, dass Sie trotz Verhoeff & Zacher bei der Benützung der äusseren Kennzeichen für die Systematik geblieben sind & die Spitzfindigkeit der männlichen Copulationsorgane erst in's Hintertreffn gestellt haben. Schliesslich hätte man nur noch mit Virga, Praeputialsack & Parameren gearbeitet & das Wichtigste, das Äussere der Tiere, wäre vernachlässigt worden. Und in den Sammlungen wären nur noch Rudimente der Tiere mit abgeschnittener Abdomenspitze zurückgeblieben"; also the distinguished Dermapterist Dr. A. Borelli, who writes me: "Credo come Lei che non bisogna fare troppi generi basandosi unicamente sulla forma dei parameri o sulla presenza di denti, strie o altri ornamente, d'altronde gli apparati genitali non sono che uno dei caratteri, bisogna tenere anche conto degli altri."

The true earwigs fall into two groups, those with a pair of penes, the Protodermaptera, and those with one, the Eudermaptera. In the former group, each præputial sac takes its origin from the

apex of the proparameres, is directed backwards in repose, so that the ejaculatory duct is doubled back upon itself; but in erection the præputial sacs are directed forward, so that the ejaculatory ducts are straightened. But in the Eudermaptera there is no discernible trace of the lost penis, and the remaining præputial sac is not reversed, but directed in repose as in erection, the protrusion being the only difference in the latter condition, consequently the ejaculatory duct is never bent; the præputial sac here seems to take its origin from the basal part of the weakened proparameres.

When we remember this, it is surprising to find that in *Hemimerus* and *Arixenia*, which are looked upon as primitive forms, one penis is rudimentary. In the former we have what is really a Eudermapterous form of penis, with single direct præputial sac and ejaculatory duct.

In *Arixenia* the rudiments of the abortive præputial sac and ejaculatory duct are discernible, and the functional sac is direct, as in the Eudermaptera, and not reversed in repose, as in the Protodermaptera. We find a somewhat, but not quite similar arrangement in the *Karschiellinæ*, as shown by Zacher, but the degeneration of the second penis is less accentuated than in *Arixenia*, the rudimentary præputial sac being discernible.

It is surprising to find in these apparently primitive groups features in the reproductive organs, and also in the opisthomeres which are associated in the so-called higher section of the earwigs. Either the *Arixenia* and *Hemimerina* are less primitive than usually considered, or we must modify the opinion which I have expressed, that the progressive degeneration of the opisthomeres is a good measure of the higher development in the Dermaptera.

The fact that in such primitive groups as the *Arixenina* and *Hemimerina*, and in the *Karschiellinæ*, one of the lowest of the *Protodermaptera*, the genitalia approach the form which generally characterises the *Eudermaptera*, or higher earwigs, compels us to believe that the reduction of one penis is not necessarily evidence of a higher stage of development, and to my mind robs the male reproductive system of much of the value that has been attached to it as evidence of the phylogenetic relationship of the various sub-divisions of the Dermaptera.

I am now prepared to modify the arrangement proposed in the Genera Insectorum (1911). I propose to sink the *Paradermaptera*, reducing them to family rank, within the Protodermaptera. The strongly flattened body is not enough to warrant the separation of the *Paradermaptera*, since, if it were, we should be obliged to raise the rank of the *Platylabiinæ* and of the *Sparattinæ*; neither has the squamopygidium, since an apparently identical structure is admittedly only given generic value in the case of *Gonolabina*.

The other chief alteration is the transference of the *Allostethinæ* from the *Labiduridæ* to the *Pygidicranidæ*, on the strength of the

presence of two pairs of gonapophyses in the female. I do this with some hesitation, but the presence of gonapophyses is certainly a primitive feature; after all, it is really only a matter of convenience in which group it is placed, for it has very sharply marked characters of its own.

I have also felt obliged to separate *Psalis femoralis* into a distinct genus and sub-family, for reasons which will appear later.

SUB-ORDER I.—**ARIXENINA**.

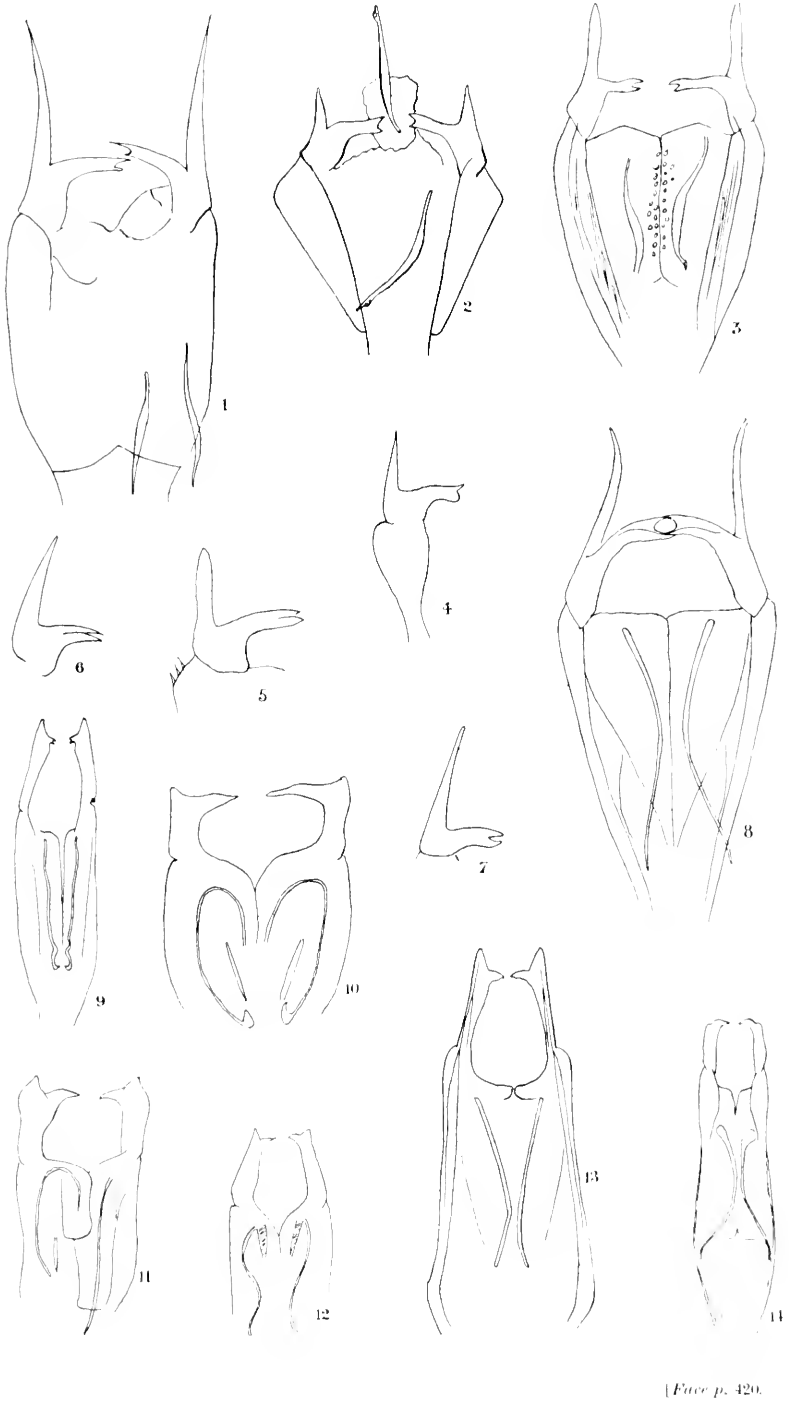
The reproductive apparatus is described in detail by Jordan and Burr in both sexes. The male organ is complicated, and differs from that of the true earwigs in having the form of a tube or cylinder, instead of being dorso-ventrally flattened. One ejaculatory is rudimentary, persisting as a blind branch on the functional duct, which runs from the seminal vesicle where the vasa deferentia meet, into the vesicle at the base of the penis, corresponding to the basal vesicle in the true earwigs. The rudimentary duct is thrown off just above this vesicle. The duct continues through the single præputial sac, corresponding to the virga, which is long and coiled.

Jordon detected a funnel-shaped cavity on the ventral side, receiving a thin tube which runs the whole length of the organ. This is probably the rudiment of the second præputial sac with its virga. This rudimentary penis is unarmed, but the functional penis has a complex chitinous armature recalling that of many *Labiidæ*. There are four irregularly shaped chitinous bars or plates; the virga is continued in a chitinous tube that joins this armature, though the duct itself does not. The proparameres are very weak and feebly chitinized; the metaparameres scarcely stronger: these are sub-cylindrical, finger-shaped, feebly chitinized and studded with sensory papillæ-like setæ. They are manipulated by a pair of strongly chitinized rods or levers, which extend

EXPLANATION OF PLATE VI.

FIG.
1. *Dicrana wigginsi* Burr.
2. *D. bettoni* Kirby.
3. *D. biafra* Borm.
4. *D. caffra* Dohrn. After Zacher.
5. *D. elongata* Zacher. After Zacher.
6. *D. phœnix* Zacher. After Zacher.
7. *Picrania liturata* Zacher (nec Stål). After Zacher.

FIG.
8. *Acnodes wellmanni* Burr.
9. *Tagalina semperi* Dohrn.
10. *Kalocrania similis* Zacher. After Zacher.
11. *K. marmoricrura* Serv. After Zacher.
12. *K. piepersi* Burr. After Zacher.
13. *Cranapygia kallipyga* Dohrn.
14. *C. dæmeli* Dohrn.



[*Face p. 420.*

through the proparameres, at least as far as the seminal vesicle: perhaps it would be correct to call these rods the true proparameres, for they act as supports and levers of the metaparameres. In the true earwigs we see an analogous arrangement, but it is always the outer margin of the proparameres that is chitinized, the inner margin being tender and membranous, exactly the converse of the case in *Arixenia*.

In erection the præputial sac is reversed, as in the Protodermaptera, and protruded far beyond the parameres, and ventrally to them, the chitinous armature being very prominent, the virga, or whip-like end of the ejaculatory duct, extending well beyond the tip of the longest chitin-plate.

Some light is thrown on the function of these plates by the figures of the organs in copula in Jordan and Burr. The furthest plate lies within a slit between the two halves of the eighth sternite of the female, and its hook catches the concave end of the clutch or chitinized knob of the female, another fits on to the apical margin of the left eighth sternite, another prevents the first from slipping off the clutch; they are in fact the apparatus by which the male grips and holds the female. The metaparameres do not seem to be used for this purpose at all, but to act rather as feelers than as claspers. In the true earwigs, the metaparameres are hard and horny, though usually softer and thinner on the inner margin, and are probably true claspers. When the chitin-plates occur in the true earwigs, they have some such function of grasping; anyhow, they give rigidity to the soft material of the præputial sac. This is noticeable in the figure.

SUB-ORDER II.—**HEMIMERINA.**

Jordan has discussed and figured the reproductive organs in *Hemimerus*. As Verhoeff insists, it is essentially of Forficuline type. The parameres are well developed; the metaparameres are long, rather dilated about the middle, tapering towards the apex, where they are recurved into a sharp but simple, slender hook, the curvature being stronger in one than in the other. There is a single ejaculatory duct, though Jordan states that "it seems to divide where it enters the outer half of the organ of copulation; but I am not sure on that point." Probably the second duct is rudimentary, as there is a single præputial sac which is densely denticulate.

The form of the metaparameres recalls that of *Acrania horsfieldi*, but this can only be a coincidence.

SUB-ORDER III.—FORFICULINA.

This sub-order contains the vast majority of the Dermaptera, that is to say, the true earwigs. They fall into two super-families, one in which the male has two complete penes, the other in which there is only one.

TABLE OF SUPER-FAMILIES.

1. Apparatus genitalis ♂ duplex, penibus 2 instructus; (apud *Karschiellinas* penis unus abortivus); penes ab apice proparamerum orientes, quum haud erecti, abdomen versus directi; proparameres fortes, chitonisi, cardine distincto (subfamilia *Echinosomatinarum* excepta, cardine debili); (pygidium ♂ simplex, telson interdum adest; opisthomeres interdum in squamopygidium haud segmentatum fusi) . . . . . 1. PROTODERMAPTERA.

1, 1. Apparatus genitalis ♂ simplex, pene unico instructus, a basi proparamerum orienti, semper apicem versus directo; proparameres vix chitinosi, cardine rudimentario; (pygidium ♂ sæpius spinis armatum; telson abest, vel rudimentarius; opisthomeres semper separati) . . . . . 2. EUDERMAPTERA.

SUPER-FAMILY I.—*PROTODERMAPTERA.*

The proparameres are distinctly separated from the metaparameres by a well-marked hinge, except in the *Echinosomatinæ*; they are chitinized through their length down the external margin, and fork distinctly from their base. The metaparameres offer a remarkable diversity of size and form, affording very valuable characters. Attached to the apex of the proparameres are the præputial sacs, or penes proper, which in the position of rest lie pointed backwards, towards the base of the segment; in erection they are protruded forwards, and capable of very considerable expansion; in each sac there is a tube called the virga, an extension of the ejaculatory duct, which offers useful characters, especially of specific value. In the *Diplatyinæ* they are horseshoe-shaped, and each virga has two vents; in many *Anisolabinæ* the virga is absent. In the *Labidurinæ* and kindred subfamilies, the virga is inflated at the base into a reniform vesicle, of delicate texture, showing under high magnification a spiral structure recalling that of the tracheæ; in the *Labidurinæ* the virga has the form of a serpentine tube inside a transparent and parallel-sided sheath.

The *Protodermaptera* fall into two groups, the *Pygidicraniales* and *Labiduriales* of Zacher, which I prefer to accept as *Pygidicranidæ* and *Labiduridæ*; they are perfectly distinct, yet it is extremely difficult to tabulate the distinctions. Zacher bluntly shirks the difficulty, saying that the groups are too hypothetical and have too few concrete characters. Unfortunately, none of the best characters lend themselves to sharply defining the two groups; if we take the presence of gonapophyses in the female, we are obliged to separate the *Pyraginæ* from their undoubted allies, the *Pygidicraninæ*, and if we take the reduction of the telson, we are similarly obliged to remove the distinctly Pygidicranine *Echinosomatinæ* into the *Labiduridæ*. The manubrium also fails to help us. In a general way, the head is flatter in the *Pygidicranidæ*, and the femora are usually keeled and compressed. In the *Labiduridæ* the parameres are generally simpler, and the virga tends to have the fine spiral structure referred to by Zacher as "Spiralversteifung," and to have an inflated reniform vesicle at the base. In the following table I have not ventured to dogmatize on the homologies of the opisthomeres in the *Labiduridæ*, and have left open the question whether the large pygidium of *Labidura* contains the metapygidium combined with it.

We are, in fact, reduced to the inconvenient necessity of making a lengthy explanation. If the female has gonapophyses, it certainly is Pygidicranine, but all Pygidicranines have not gonapophyses, e.g. the *Pyragrinæ*; we know at least that if we find gonapophyses, there is no question of a Labidurid. Again, if all these segments of the opisthomeres are present and separate, and the telson distinct and chitinous, we know we have to do with a Pygidicranid; one of these two tests applied separately, and often both simultaneously, will enable us to discriminate the two families.

Table of Families.

1. Gonapophyses ♀ adsunt; aut, opisthomerum 3 segmenta separata, telsone perfecto . . . 1. Pygidicranidæ.

1, 1. Gonapophyses ♀ desunt; opisthomerum sæpius segmenta tantum 2 adsunt; (interdum telson (?) rudimentarium, membranaceum, adest.) . . 2. Labiduridæ.

Family PYGIDICRANIDÆ.

Zacher deals with the group in considerable detail, but omits to characterize it, and to discriminate it from the *Labiduridæ*. Verhoeff defines it in a restricted sense by the development of the opisthomeres.

If we limit it to those groups in which the telson is free, we

exclude the *Echinosomatinæ*, and perhaps also the *Pyragrinæ*, which have Pygidicranine affinities; on the other hand, if we define it by the presence of gonapophyses in the female, we bring in the *Allostethinæ*. Unfortunately, the latter organs have not been examined in the *Diplatyinæ*, *Karschiellinæ*, and *Pyragrinæ*. The *Karschiellinæ* are a very primitive group, having segmented caudal setæ in the larval instars like the *Diplatyinæ*, and probably gonapophyses are present in the females of both. Fortunately there is no difficulty in discriminating these groups, all of which are well characterized by other features. It therefore becomes a merely academical question whether we shall include in the *Pygidicraninæ* those groups in which the female has gonapophyses but reduced telson. As a matter of pure convenience, therefore, I prefer to define the *Pygidicraninæ* as that group in which either the telson is free, or, alternately, in which the female has gonapophyses; in some cases, both features may be present simultaneously. This, I admit, is presuming for the moment the presence of gonapophyses in the female of the *Pyregrinæ*, *Karschiellinæ*, and *Blandicinæ*, which remains to be demonstrated.

The original feature of this arrangement is the inclusion of the *Allostethinæ* on the strength of the presence of gonapophyses of the female, which has not previously been recorded.

Table of Sub-families.

1. Femora compressa ac carinulata (gonapophyses ♀ adsunt).
    2. Antennæ setaceæ, segmentis 15–25, quinto elongato.
        3. Corpus apterum; metanotum larvale; metasternum postice truncatum; cerci larvarum haud segmentati; virga simplex; oculi parvi . . 1. Anatælinæ.
        3, 3. Corpus alatum; metanotum haud larvale; metasternum postice concavum; cerci larvarum segmentati; virga bifurcata; oculi magni . . 2. Diplatyinæ.
    2, 2. Antennæ 25–33 segmentatæ, quinto et sexto brevibus.
        3. 1 penis abortivus; antennæ crassæ, segmentis 4, 5, et 6 transversis; cerci larvarum segmentati; (genera ethiopica) . . . . . . 3. Karschiellinæ.
        3, 3. Ambo penes perfecti; antennæ setaceæ, segmentis 4, 5, et 6 brevibus, sed haud transversis; cerci larvarum haud segmentati . . 4. Pygidicraninæ.

1, 1. Femora nec carinulata nec compressa.

2. Gonapophyses ♀ adsunt; metaparameres angusti.

3. Pro- ac mesosterna postice haud angustata; tarsorum segmentum secundum haud lobatum; manubrium rotundatum; corpus valde pilosum; cardo paramerum debilis; genus palæotropicale . . . 5. ECHINOSOMATINÆ.

3, 3. Pro- ac mesosterna postice acuminata; tarsorum segmentum secundum lobatum; manubrium apice angustatum; corpus haud valde pilosum; cardo paramerum fortis; genera indomalayana . . . 6. ALLOSTETHINÆ.

2, 2. Gonapophyses ♀ desunt (?).

3. Antennæ 25–35 segmentatæ; prosternum antice acutum; genus neotropicale . . . . . . 7. PYRAGRINÆ.

3, 3. Antennæ 25 segmentatæ; prosternum antice rotundatum; genus capense 8. BLANDICINÆ.

Sub-family 1. ANATÆLINÆ.

I have a single mount, unfortunately somewhat damaged, of the genitalia of the rare and curious species *Anatælia canariensis.*

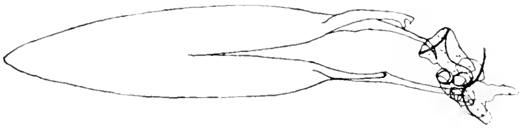


FIG. 57.—*Anatælia canariensis* Bol.

The metaparameres are much shorter than the proparameres, slender and gently curved, the tips turned in and bilobed; in the præputial sac are to be seen what appears to be the endless coils of a long virga, with chitinous indurations.

Sub-family 2. DIPLATYINÆ.

Very marked characters are afforded by the genital armature in this group. Zacher only knew a few species, and so his proposed arrangement is extremely incomplete. The examination of a number of additional species has shown that there is a great diversity of structure in the genitalia of the *Diplatyinæ*, but it is yet premature to base the classification of the sub-family upon these characters. I have therefore refrained from erecting a host of new genera for every shape of penis and virga, and have retained

my original arrangement, provisionally, and confine myself to some observations on the genitalia of the group.

The virga possesses one very well-marked peculiarity; it is invariably horseshoe-shaped, and, as there are a pair of them, there are four orifices for the emission of the semen. In all known *Diplatyinæ* this is the case, though the shape of the virga is various, and the metaparameres offer considerable diversity.

Zacher's arrangement of this genus has the merits of boldness and originality, but I am convinced that he has in some cases failed to identify his species correctly. This is a very pardonable mistake in this genus, where I often have considerable doubt in identifying individuals of species of my own description.

Diplatys macrocephalus Beauv.

This has always been regarded as a purely West African species, but I cannot distinguish, by external characters, a fresh specimen from Uganda, sent to me by Mr. Gowdey (Pl. V. *fig.* 9). The metaparameres are quite peculiar, being very strongly bowed, with the apex produced into a sharp point. The virga is short, and there is a denticulate pad.

It is important to examine the parameres of West African specimens to settle this question of identity, for the genitalia figured by Zacher and attributed to this species are totally different. Zacher's specimens are from Usambara, and he relies upon the unreliable determination of Verhoeff. It remains to be seen to what species these figures should be attributed (Pl. V. fig. 14).

Diplatys conradti Burr.

My original type is in poor condition, and the genitalia are inaccessible, but I have examined these organs in a specimen, also from the Kamerun, which I attribute hereto, and I find the genital figured by Zacher as those of *D. æthiops* (Pl. V. fig. 11).

The *D. conradti* of Zacher is another species. I cannot admit Zacher's sub-genus *Verhœffiella*, based on the length of the virga, as we find this organ nearly as long in some Indian species closely allied to forms with short virga. It is, in fact, only a specific character.

Diplatys riggenbachi Burr, and *D. raffrayi* Borm.

Here the metaparameres are slender, and of a peculiar shape; the virga is short (Pl. V. figs. 7 and 8).

Diplatys sp. n.

A very characteristic form of genitalia is seen in a species not yet described, from Sappo, Kamerun, in the Berlin Museum. It is

the same as that figured by Zacher under the name *D. conradti.* The metaparameres are unusually broad at the base, rapidly narrowing to a finger-like point, with an acute epimerit (Pl. V. figs. 12 and 15). The virga is short and hard, and on one side of my specimen has assumed a position out of the plane of the mount, and so cannot be seen clearly, but it is clear on the other side; it is strong and black, each branch inflated before the tip. In the præputial sac around the virga is a chitinous fibrous structure. The whole form of the genitalia agrees well with Zacher's figure except that of the virga, which is difficult to see, and Zacher expressly states that his specimen, prepared by Verhoeff, is very obscure.

The peculiar virga, digitate metaparameres, and the presence of the epimerit justify Zacher in the erection of the sub-genus *Paradiplatys* for it.

The genus *Diplatys*, as restricted by Zacher, is probably to be confined to those forms having narrow, acuminate metaparameres, with an inner tooth, and the virga with an inflation at the base, and the branches short; such are *D. macrocephalus* Beauv.,* *D. raffrayi* Borm., and *D. riggenbachi* Burr, all Ethiopian species. In the Indian *D. lefroyi* Burr, which resembles the above African species in the inflated last abdominal segment of the male, and basally dilated, arcuate forceps, we have a similar general form, but the branches of the virga are extremely long; the genital armature of the Indian, *D. rufescens* Kirby, is very similar, with long virga, but there is no basal inflation; also, the Indian *D. gladiator* Burr has a long virga, and not very dissimilar metaparameres, and the virga has apparently a pair of basal dilations.

Zacher makes a separate sub-genus for the Ethiopian species, which he identifies as *D. æthiops* Burr, but which I consider *D. conradti*, where the virga is very long, and not inflated at the base. But as the general form of the metaparameres is the same, and the very long virga is found equally in Indian and African species, as also the basal dilation, I suppress Zacher's proposed sub-genus *Verhoeffiella*, as, if we accept it, we are obliged to erect a whole batch of fresh genera or sub-genera.

We may group those species with narrow, toothed, acuminate metaparameres, as follows:—

Virga long.	Virga short.	
..	*Macrocephalus*	. African.
..	*Riggenbachi*	. . African.
..	*Raffrayi*	. . African.
Lefroyi.	*Liberatus* .	. . Indian.
Gladiator.	*Gerstæckeri*	. . Indian.
Rufescens.	*Bormansi*	. . Indian.

* Cf. Zacher, 1911, figs. D[1] and E[1].

Of these, the virga has a basal inflation in *D. macrocephalus*, *D. riggenbachi*, *D. ruffrayi*, *D. gladiator*, and *D. lefroyi*.

As specific peculiarities, we note the strong denticulation of the præputial sac in *D. macrocephalus*, its slight denticulation in *D. gladiator* and *D. liberatus*. The plates show the specific differences in the form of the metaparameres; the presence of a second smaller tooth should be noted in *D. liberatus*, and the form of these parts in *D. bormansi* is quite characteristic.

As to the genus *Nannopygia* Dohrn I feel sure that we are in the presence of another of Verhoeff's mistakes, which has misled Zacher. I am convinced as to the identity of my Cingalese specimens with *N. gerstæckeri* of Dohrn, and my figure shows as quite typical Diplatyne armature, whereas Zacher states that Verhoeff's specimen, with no indication of locality, has bifid metaparameres, and places it with his *N. picta* from British East Africa. It is very easy to make a mistake of identity in this group, and Verhoeff may have had *D. ernesti* Burr, or *D. jacobsoni* Burr, before him, in neither of which are the genitalia yet known. Anyhow, the genitalia of my *D. gerstæckeri* are not, in my opinion, generically different from those of the other species considered, and I maintain my long-stated opinion, that *Nannopygia* cannot be generically separated from *Diplatys*. If it ever is, it will be upon the form of the ninth sternite and forceps.

Zacher's *N. picta* has a peculiar form of metaparamere which would better justify a new genus than the virga, and approaches the form seen in his figure of *D. vosseleri* Burr. In both the metaparameres are broad and bifid, and on this I should be willing to grant them generic rank; in both there is a denticulate area in the præputial sac. In *D. vosseleri* the virga is basally inflated, and in *D. picta* it is decidedly longer. This is further evidence in favour of my contention that the virga offers characters rather of specific than of generic value.

I should have felt inclined to give generic value to the form of the forceps and last abdominal segment, but for the fact that *D. ruffrayi* differs in this respect from *D. macrocephalus*, yet agrees with it in the form of the genitalia.

But after all, a comparison of the figures shows that these peculiar forms of metaparamere in *D. vosseleri* and *D. picta* are

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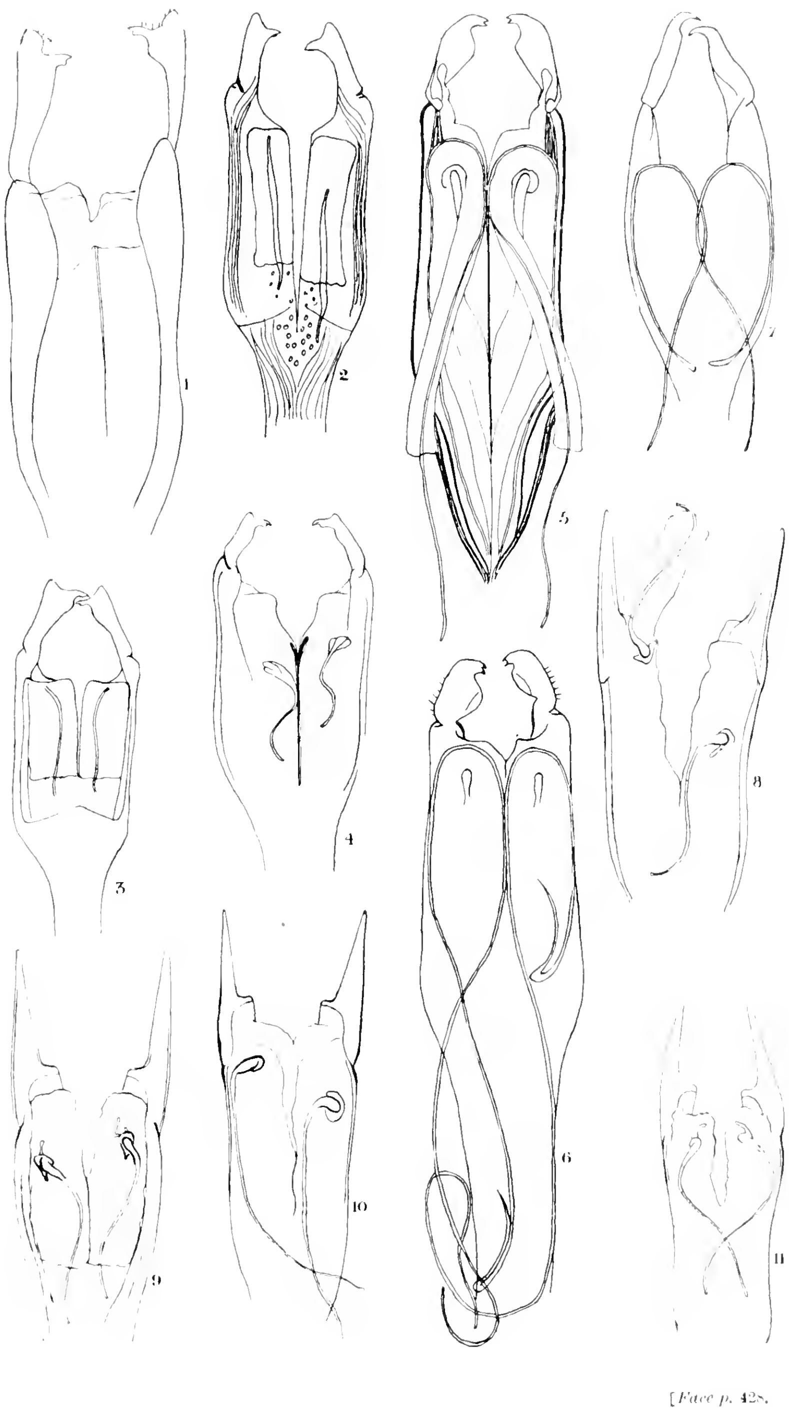
EXPLANATION OF PLATE VII.

FIG.
1. *Cranopygia valida* Dohrn.
2. *C. cumingi* Dohrn.
3. *C. modesta* Borm.
4. *C. sauteri* Burr.
5. *Acrania eximia* Dohrn.
6. *A. picta* Guer.

FIG.
7. *Acrania horsfieldi* Kirby.
8. *Echinosoma occidentale* Borm. (Entebbe.)
9. Ditto, ditto. (Kamerun.)
10. *E. fuscum* Borm. (Kuako.)
11. Ditto, ditto. (Entebbe.)



[Face p. 428.

merely modifications of the normal Diplatyne type, by blunting and armature of the points.

Other specific characters to be noted in this group are the occasional striated, chitinous structures at the base, and hooks and spines at the tip, of the virga, and the occasional presence of denticulate areas in the præputial sac.

The Neotropical *Cylindrogaster* Stål will probably require to be restored when the material is available.

I can detect no traces of gonapophyses in the female of *D. gladiator*.

In the same species the manubrium is scarcely differentiated from the membranous base of the ninth sternite; it is very short, transverse, and rounded.

Sub-family 3. Karschiellinæ.

This is a very well-marked Ethiopian group, with two genera, *Karschiella* Verh. and *Bormansia* Verh. The discrimination of the species is difficult, and I long considered them not to be valid, but it seems that good characters are afforded by the genitalia, and as these are figured by Zacher, presumably from Verhoeff's original material, we now have definite means of discriminating at least most of the species. The genitalia of *B. meridionalis* Burr, and of *B. orientalis* Bor., are still unknown, but I am daily expecting the arrival of some fresh specimens of the former from Rhodesia, which will give the information required.

Genus *Karschiella* Verh.

The three known species of *Karschiella* may be distinguished as shown below; for want of clear discrimination I prefer to sink *K. bidentata* Zacher as a synonym of *K. neavei* Burr.

1. Segmentum anale ♂ processu nullo instructum, solum utrinque carinatum; parameres denti brevi armati (Pl. V, figs. 20 and 21) . . . . 1. *Neavei* Burr.*

1, 1. Segmentum anale ♂ processu acute utrinque instructum.

2. Pronotum distincte transversum; processus anales paralleli; parameres dente interno longiori, ad angulum autum inserto (Pl. V. fig. 19) . . . . 2. *Büttneri* Karsch.

2, 2. Pronotum haud transversum; processus anales divergentes (?); parameres dente interno ad angulum rectum inserto, breviori (Pl. V. fig. 18) . . . . 3. *Camerunensis* Verh.

* This species is somewhat larger than the other two; the form of the metaparameres is quite distinctive.

Genus *Bormansia* Verh.

This genus agrees generally with the preceding, which it replaces in Eastern Africa, but it may be distinguished at once by the entire absence of any rudiments of elytra, and the consequently differently constructed pronotum. Of the four known species, *B. orientalis* Bor. and *B. meridionalis* Burr have not yet been examined in this respect, but the two original species of Verhoeff's can be separated, according to the figures give by Zacher, presumably from Verhoeff's originals; the features given by Verhoeff are certainly scarcely sufficient to justify the separation of these two species.

I have not had the opportunity of examining the genitalia of this genus, but Zacher figures and describes it; the virga appears to be complex.

TABLE OF SPECIES.

1.	Forceps ♂ dente valido armatus.	
2.	Pronotum fere quadratum (Pl. V. fig. 22)	1. *Africana* Verh.
2, 2.	Pronotum latius quam longius, antice angustatum, subacutum (Pl. V, fig. 23)	2. *Impressicollis* Verh.
1, 1.	Forceps ♂ inermis	3. *Meridionalis* Burr.

Sub-family 4. PYGIDICRANINÆ.

The old comprehensive genus *Pygidicrana* of Serville was first sub-divided in 1908, when I erected four new genera, based chiefly upon the form of the pronotum and of the ninth sternite of the male.

In 1911 a further arrangement was proposed by Zacher, based on certain new characters, the chief being the genital armature. This arrangement was admittedly provisional only, as the author had but meagre material at his disposal.

I have been able to examine, and here figure, the genitalia of a number of additional species, which involves a recasting of both existing systems. I find a considerable diversity of form in the male genitalia, which I am prepared to admit offer better generic characters than the width of the pronotum and ninth male sternite, formerly employed by me, and it is necessary to modify the arrangement and definition of the genera, which fall into fairly well-defined geographical groups, much better indeed than they did under the old arrangement. As a specific instance let us take the genus *Pyge* Burr, the type of which is the Oriental *P. modesta* Borm. The characteristic of this genus as defined originally is the

strong abbreviation of the organs of flight. Now, species in South America on one hand, and in the Malay Archipelago on the other, being simultaneously subject to the tendency towards brachypterism which is so general in the Dermaptera, will show the abbreviation in the same way, so that two species, inhabiting widely separated districts, may both show similar brachypterism by convergence, and therefore fall into the genus *Pyge* as originally defined, without being actually closely allied, and I think that the genital armature will more truly show the phylogenetic relationship, and be less subject to convergence, than the development or abbreviation of the organs of flight. I feel therefore justified in re-arranging the genera about their respective types according to the form of the male reproductive organs. We at once see that the genera, as thus re-arranged, fall into more natural geographical groups.

There are two types of virga. One is very long, many times as long as the metaparameres, and coiled; this is seen in *Acrania*. The other type is short, and may be strongly bent, with or without a chitinous reflexed lobe at the base, or straight and simple.

The metaparameres are of four types—broad, dilated, as in *Pygidicrana*; lanceolate, with lanceolate tooth, as in *Dicrana* and *Acnodes*; apically knobbed, with a broad tooth, as in *Kalocrania*, *Cranopygia*, and *Tagalina*; or knobless, and curved into a sharp hook, as in *Acrania*.

I have wished to avoid creating new genera until more extensive material is available, and have confined myself to erecting one for *Kalocrana picta* and its allies, with a very distinctive form of metaparameres and virga; but probably new genera will be required for *Acrania horsfieldi*, *Kalocrania dæmeli*, and *Acnodes americana*.

In *Acrania picta* Guér. the manubrium is parallel-sided, rounded at the tip, a little broader than long.

Table of Genera.

1. Metaparameres nec dentati nec mucronati, sed dilatati; (genus americanum) . . . 1. *Pygidicrana* Serv.

1, 1. Metaparameres vel mucronati vel dentati; (genera mundi antiqui, *Acnode americano* excepto).

2. Metaparameres lanceolati, denti forti et acuto, angusto; genera ethiopica.

3. Caput pronoto angustius; segmentum penultinum ventrale ♂ angustum . . . . . 2. *Picrania* Burr.

3, 3. Caput tam latum quam pronotum; segmentum penultimum ventrale ♂ latum.

4. Elytra et alæ perfecte explicata 3. *Dicrana* Burr.

4, 4. Corpus omnino apterum . 4. *Acnodes* Burr.

Table of Genera—*continued.*

2, 2. Metaparameres haud lanceolati, mucronati vel lobati; genera orientalia et australica.	
3. Tarsorum segmentum primum ac secundum valde dilatata; metaparameres lobati; genus papuum	5. *Tagalina* Dohrn.
3, 3. Tarsorum segmenta haud lobata.	
4. Metaparameres apice lobati, obtuse dentati.	
5. Virga basi mucronata, circa triplo longior quam metaparameres; (segmentum penultimum ventrale ♂ latum; elytra perfecta; genus orientale) .	6. *Kalocrania* Zach.
5, 5. Virga subrecta, simplex, quam metaparameres sesquilongior . .	7. *Cranopygia* Burr.
4, 4. Metaparameres haud lobati, sed mucronati; virga longissima, quam metaparameres 6–18 longiores . . .	8. *Acrania* g.n.

Genus *Pygidicrana* Serv.

This genus is now restricted to the American forms. Zacher figures the genital armature in *P. V-nigrum* Serv., the type of the genus, and in *P. fiebrigi* Burr, which are the only two species so far examined in this respect; possibly some of the other species, which are at present scarcely known, will require new genera. I have shown the outlines of the metaparameres of the abovementioned species, from Zacher, for purpose of comparison (Pl. V. figs. 24 and 25).

Genus *Picrania* Burr.

This genus, with the following two, makes a natural group, confined to the Ethiopian region, with a well-marked type of genital armature. The long, narrow metaparameres, with lanceolate tooth, are characteristic of *Picrania*, *Dicrana*, and *Aenodes*; they are only known in African species, and all known African species have that type of armature.

Picrania itself is only distinguished from *Dicrana* by the narrow head, which is no broader than the pronotum. There is a single undoubted species, *P. liturata* Stål, the type of the genus, which unfortunately is only known from Stål's original nomotype in the Stockholm Museum. Professor Sjöstedt has been good enough to send me an excellent water-colour of this specimen,

which is a female; and therefore we must await the discovery of the male before the truly typical genitalia of the genus can be described, but there is every reason to believe that they will be found to closely resemble those of the other African species.

The creature described by Zacher under the name of *P. liturata* is certainly not that species; his original specimen from Bulongwa is in the Berlin Museum (Pl. VI. fig. 7). The apex of the abdomen has been lost, which does not matter so very much, since Zacher has described and figured the metaparameres, which are uncommonly like those of *D. wigginsi* Burr; it seems that Zacher was depending on Verhoeff's determination. There is a label attached to the specimen in Verhoeff's writing, "*Pyg. phœnix aberrans*," which is rather confusing, as the *P. phœnix* of Zacher is a West African species, from the Kamerun, which is unknown to me, and insufficiently described.

Accordingly, *Picrania* is now restricted to the type species, *P. liturata* Stål, of which the male is unknown; *P. angustata* Dohrn must be removed to *Kalocrania* or perhaps to *Cranopygia*; the so-called *P. liturata* of Zacher is uncommonly like *D. wigginsi* Burr, but a size smaller; and *P. phœnix* of Zacher remains a doubtful species until his type has been identified, figured, and redescribed

Genus *Dicrana* Burr.

The type of *Dicrana* is *D. frontalis* Kirby, the genitalia of which have not yet been examined, but as all Ethiopian Pygidicranids so far studied have similar genitalia we may expect *D. frontalis* to be of the same form until it is proved otherwise, and *Dicrana* is restricted to the Ethiopian forms having long lanceolate metaparameres, with a long, narrow apically bifid, internal tooth (Pl. VI. figs. 1 to 6). Zacher figures *D. caffra* Dohrn and *D. elongata* Zacher, which I do not yet know. I add *D. bettoni* Kirby, *D. biafra* Borm, and *D. wigginsi* Burr. I also include *Picrania phœnix* Zacher as having parameres of the same type, since Zacher gives us reason for including it in *Picrania*, as defined by me.

It should be noted that in his table of genera Zacher refers to a single tooth, but in his figures of *D. caffra* and *D. elongata* he distinctly shows the inner tooth of the metaparameres to be bifid.

Species definitely ranged here—

D. bettoni Kirby.	*D. caffra* Dohrn.
D. wigginsi Burr.	*D. phœnix* Zacher.
D. elongata Zacher.	*D. biafra* Borm.

Species probably to be ranged here—

D. separata Burr.	*D. frontalis* Kirby.
D. livida Bor.	

It will be noted that the genitalia of *D. caffra*, as figured by Zacher, are practically identical with those of *D. bettoni* Kirby figured here. This may mean, either that the latter is merely the macrolabious form of *D. caffra*, or that Zacher's identification is incorrect.

My figure of *D. wigginsi* Burr shows a metaparamere so like that figured under the name of *Picrania liturata* by Zacher that I expect here, too, there is identity (Pl. VI. fig. 1).

Table of Species.

1. Elytra abbreviata, alæ abortivæ . . .	1. *D. wigginsi* Burr.
1, 1. Elytra et alæ perfecta.	
2. Segmentum penultimum ventrale ♂ margine postico medio exciso.	
3. Forcipis bracchia ♂ contigua, recta.	
4. Elytria unicoloria . .	2. *D. biafra* Burr.
4, 4. Elytra maculata . . .	3. *D. grotei* Burr.
3, 3. Forcipis bracchia ♂ arcuata .	4. *D. elongata* Zacher.
2, 2. Segmentum penultimum ventrale ♂ margine postico integro.	
3. Forcipis bracchia ♂ brevia, fortiter arcuata.	
4. Forcipis bracchia ♂ ante apicem dilatata . .	5. *D. bettoni* Kirby.
4, 4. Forcipis bracchia ♂ ante apicem fortiter dentata .	6. *D. caffra* Dohrn.
3, 3. Forcipis bracchia ♂ longiora, leviter arcuata.	
4. Elytria vittis angustis rufescentibus 2 ornata . .	7. *D. frontalis* Kirby.
4, 4. Elytra macula pallida ornata	8. *D. separata* Burr.
♂ ignotus . . .	9. *D. livida* Bor.

Genus *Aenodes* Burr.

The type of this genus, *A. wellmanni* Burr, from Portuguese West Africa, has typically Ethiopian parameres, and the total apterousness is the only character which separates it from *Dierana* Burr (Pl. VII. fig. 8).

The apterous American species, *A. americana* Burr, which has so strong a superficial resemblance to *A. wellmanni*, will probably require to be removed to another, and perhaps new, genus when the genitalia are examined.

Genus *Tagalina* Dohrn.

This old genus remains characterized by the peculiar form of the tarsi; the male reproductive organs are of the same general type as those of *Cranopygia* (Pl. VI. fig. 9).

Genus *Kalocrania* Zacher.

Zacher formed this genus for the Oriental species, fixing *marmoricrura* as the type, figuring that species, and *similis* Zacher, which I am inclined to think may be identical with *siamensis* Dohrn.

The metaparameres are rather broad, with a blunt knob at the apex, and a blunt tooth on the inner margin near the apex. In *Kalocrania dæmeli* this knob is nearly obsolete, showing a transition towards the mucronate metaparameres of *Acrania*.

Zacher describes the virga of *K. marmoricrura* as straight, yet he figures it as doubled at the base of the præputial sac, there being no marked division between it and the ejaculatory duct (Pl. VI. figs. 10 and 11). Including as virga the whole tube from the hook near the base of the proparameres, the virga is about four times as long as the metaparameres in both *marmoricrura* and *similis*. I bring in here *P. piepersi* Burr from *Pyge*, as now I refuse generic value to mere reduction of elytra (Pl. VI. fig. 12).

Genus *Cranopygia* Burr.

This genus may have to be sunk in *Kalocrania*, or rather, if they eventually coincide, it is *Kalocrania* which will be sunk in the prior *Cranopygia*, but the definition of the latter must be modified; the metaparameres are of very similar design to those of *Kalocrania*, but the virga is shorter, and straight (Pl. VI. figs. 13 and 14). Until the larger number of species have been examined, it is worth while retaining this genus, but enlarging it, so as to include *kallipyga* Dohrn, and *dæmeli* Dohrn, which were formerly wrongly included in *Dicrana*, before the restriction of that genus to Ethiopian species. *K. valida* Dohrn will also come here from *Kalocrania*; it is close to *C. cumingi* (Pl. VII. fig. 1).

The narrow ninth sternite of the type species, *C. cumingi*, can no longer be regarded as the defining character of the genus, since *C. kallipyga* and *C. dæmeli* are included here, and as also brachypterism is rejected as a good character, it logically follows that *Pyge* Burr must fall; the genitalia of its type, *P. modesta* Borm. and of *P. sauteri* Burr are of the same general type (Pl. VII. figs. 3 and 4).

Genus *Acrania* g.n.

Metaparameres intus inflati, extus rotundati, apice recurvi, mucronati, sæpius bifidi; virga simplex, longissima.

Metaparameres inflated on inner margin, rounded externally, the tips hooked, often bifid; virga simple, very long.

Type of the genus, *Acrania picta* Guér.

In external structure agrees generally with *Kalocrania*; but the metaparameres are neither knobbed nor toothed, but recurved into a sharp hook, which is bifid at the apex in *A. picta* Guér and *A. eximia* Dohrn, but simple in *A. horsfieldi* Kirby.

A further characteristic of the genus is the great length of the virga; from the extreme base, at the roots of the proparameres, it extends as a simple tube up the entire length of the proparameres, right through the præputial sac, extending, even in repose, far beyond (Pl. VII. figs. 5 to 7).

In *A. picta* the virga is armed at the base with a long, narrow, curved, acute, chitin plate, and the whole virga is nearly eighteen times as long as the short metaparameres, but is not convoluted.

In *A. eximia* the virga is similar, but I can detect no basal armature; the metaparameres are a little longer and the virga is a little shorter, so that the latter is about six times as long as the former.

A. horsfieldi is rather different, and will perhaps require a distinct genus; its narrow ninth sternite of the male and general slender build distinguish it from the sturdy *A. picta* and *A. eximia*, and the metaparameres are longer and the hook is entire, not excised at the apex. The virga is about six times as long as the metaparameres, with a slight basal enlargement.

Sub-family 5. Echinosomatinæ.

This is a well-characterized sub-family, palæotropical in distribution, corresponding to the allied Neotropical *Pyragrinæ*.

Zacher has called attention to several remarkable features in the genital armature. The metaparameres are long and narrow in the apical portion, and broad and dilated at base, the attenuation

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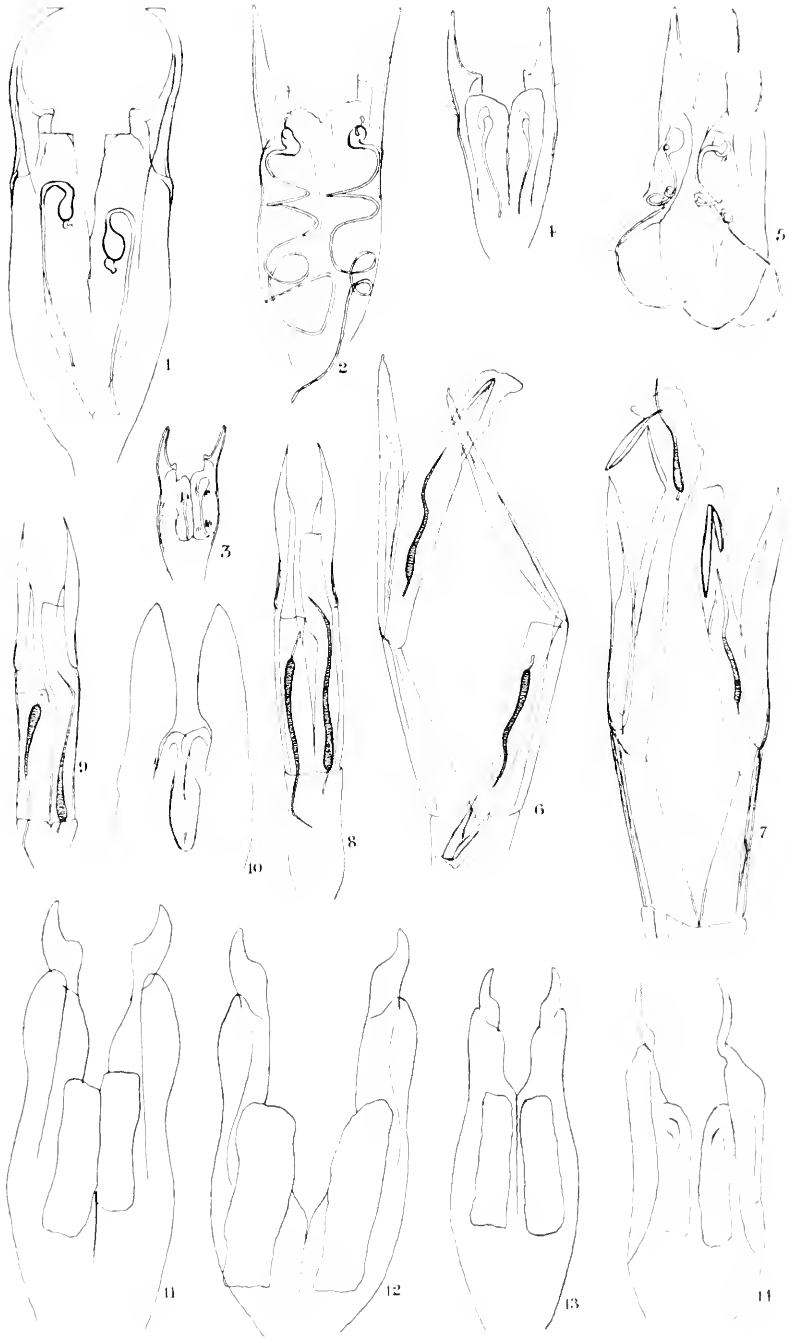
EXPLANATION OF PLATE VIII.

FIG.
1. *Echinosoma bolivari* Rodz.
2. *E. wahlbergi* Dohrn.
3. *E. parvulum* Dohrn.
4. *E. sumatranum* Dohrn.
5. *E. distanti* Burr.
6. *Gonolabidura astruci* Burr.
7. Ditto, ditto.
8. *Allostethella doriæ* Dubr.

FIG.
9. *Allostethella doriæ* Dubr.
10. *Allostethus indicum* Hagenb. (nymph).
11. *Pyragra fuscata* Serv.
12. *P. dohrni* Sauss.
13. *Pyragropsis paraguayensis* Bor.
14. *P. thoracica* Serv.



[Face p. 436.

beginning abruptly near the base. Zacher describes this as a tooth, connected to the proparameres by a fine chitinous membrane, but the membrane is really a rigid but thin chitinous plate, and an essential part of the metaparameres, comparable to the delicate inner membrane so well seen in the *Psalidæ*. The hinge is degenerate, and the junction of the pro- and metaparameres recalls that of the Eudermaptera. At the base of the virga is an inflated vesicle not unlike that seen in certain *Pygidicranidæ*, e.g. *Cranopygia dæmeli*, and in the *Forficulidæ* among the Eudermaptera. The virga is relatively short, not much longer than the metaparameres, in some species, or five or six times as long, and convoluted, in others.

A noteworthy feature is seen in the two pairs of gonapophyses of the female. The pair of the eighth segment is long and slender, but not so very long as in the *Pygidicranidæ*. The pair of the ninth segment is broad and flat; both pairs are strongly pubescent. These will probably afford useful taxonomic characters.

The validity of several of the so-called species is much open to question; for instance, the Indo-Malayan group of *E. sumatranum* Haan, *westermanni* Dohrn, and *horridum* Dohrn, will probably be shown to be one species. The African *Echinosomas* fall into two groups, the small species, as *E. sekaluvum* Borm and *E. congolense* Bor., on one hand, and the big forms *E. afrum* Beauv., *E. occidentale* Borm, *E. fuscum* Bor., *E. wahlbergi* Dohrn, *E. distanti* Burr, *E. bolivari* Rodz., and *E. insulanum* Karsch, on the other.

Probably *E. bolivari* and *E. insulanum*, both Madagascan forms, should be united, as also the colour variant from the Seychelles recorded by me as *E. bolivari* var. Of the Continental forms I think *E. distanti* Burr is to be fused with *E. wahlbergi* Dohrn, and *E. fuscum* Bor. with *E. afrum* Beauv., of which *E. occidentale* Borm is a local race, well marked by the peculiar colouring of the elytra.

The Papuan and Australian *E. forbesi* Kirby, and *E. yorkense* Dohrn, seem to be another pair, only differing really in size. *E. parvulum* Dohrn, from Ceylon, is certainly a good species (Pl. VIII. fig. 3).

As to the genitalia, *E. bolivari* is well characterized by the form of the metaparameres, which are narrow, gently arcuate, and truncate at the apex. If Zacher's identification of *E. insulanum* is correct, and I see no reason to question it, more particularly as he had access to Karsch's type in the Berlin Museum, it is practically identical, the slight differences seen in the virga being easily accounted for by differences of point of view and preparation.

E. wahlbergi is well characterized by the long convoluted virga, also seen in *E. distanti*, which I feel I must accordingly reduce to the rank of a merely well-developed form of the same species (Pl. VIII. figs. 2 and 5).

Of the large Continental Ethiopian species, I have mounts of *E. fuscum* from Kuako, *E. occidentale* from Entebbe, *E. afrum* from Entebbe and from Spanish Guinea, and *E. occidentale* from the Kamerun (Pl. VII. figs. 8 to 11). I can find no specific distinction in their genital armature, and consequently feel obliged to regard them as mere colour variants of the original species, *E. afrum* of Palisot de Beauvois.

These three principal Ethiopian species may accordingly be tabulated as follows :—

1.	Metaparameres arcuate, and apically truncate .	*E. bolivari* Rodz.
1, 1.	Metaparameres straight and angustate.	
2.	Virga moderately long	*E. afrum* Beauv.
2, 2.	Virga very long and convoluted . .	*E. wahlbergi* Dohrn.

The genitalia of the Indo-Malayan *E. sumatranum* agree very closely with those of *E. afrum*, and those of the small Cingalese *E. parvulum* are almost the same (Pl. VIII. fig. 3).

In the latter the virga is short and nearly straight; the hinge is only visible as a thickening in the chitin.

Sub-family 6. ALLOSTETHINÆ.

This group has been discussed in great detail by Zacher. The metaparameres are narrow, long, and lanceolate; the virga is rather broad basally, attenuate gradually. It is not very clearly figured by Zacher. We meet here for the first time with a fine spiral network, called by Zacher "Spiralversteifung," which is so familiar a feature in the later groups; it remains to be seen whether its function is, as Zacher's name suggests, a protective apparatus to give rigidity to a delicate structure, or whether it is a muscular contrivance for the contraction of the virga to effect or assist ejaculation. It is only seen where the virga is inflated to form a vesicle, or the beginning of a vesicle, as in this sub-family; in appearance it resembles the armature of the tracheæ.

Zacher states in a general way that the virga is relatively short, only about one-third of the length of the penis; this is true in *Allostethus* and *Gonolabidura*, but in *Allostethella doriæ* the virga is much longer (Pl. VIII. figs. 8 and 9). As the præputial sac is an elastic organ, it is better to compare the length of the virga with the rigid metaparameres. From Zacher's figures the virga appears to be a little more than half as long as the metaparameres in *A. indicum* and less than half as long in *Gonolabidura volzi*, and a trifle longer in *Allostethella malayana* Zacher. In *Gonolabidura astruci* Burr it is about half as long as, and in *Allostethella*

doriæ Dubr. a little longer than, the metaparameres (Pl. VIII. figs. 6 and 7).

I maintain firmly the conviction that I have expressed elsewhere, that *Gonolabidura volzi* Zacher is identical with *G. piligera* Borm., and that *Allosthetella* (which should be written *Allostethella*) *malayana* Zacher and *A. nitens* Zacher are but familiar colour-variants of *A. doriæ* Dubr.

Gonolabidura astruei Burr, the first Allostethid recorded from India, has the genitalia typical of the group, but noteworthy is the narrow double chitin-plate in the apex of the præputial sac.

I cannot understand why Zacher brings the names *Gonolabis* and *Esphalmenus* into discussion under this sub-family. He implies that I have suggested at some time a relationship between those genera and the *Allostethidæ*, of which I am entirely innocent.

The female has two pairs of gonapophyses, the first pair broad and rounded, delicate and membranous, the second pair narrower. I cannot find any mention of them either in Verhoeff nor in Zacher.

In *A. indicum*, the manubrium is rather narrow, distinctly longer than broad, almost parallel-sided, and rounded at the tip (Pl. VIII. fig. 10).

Sub-Family 7. PYRAGRINÆ.

This group was practically unknown to Zacher, so that he confines himself to a statement as to the reduction of the female gonapophyses.

Unfortunately I have had no fresh or spirit material to examine, and so have been obliged to content myself with the preparation of very old and dry specimens, in none of which is the virga discernible, but the form of the parameres is quite distinct. The metaparameres are much shorter than the proparameres, and are socketed in with a distinct hinge. The metaparameres are convex on the outer margin, narrowed at the tips, concave on the inner margin in the apical half, with a blunt, rounded projection in the basal half, which corresponds to the inner basal tooth in the *Echinosomatinæ*, which are undoubtedly related to the *Pyragrinæ*.

I can detect no difference between the genitalia of *Pyragra fuscata* Serv. and *P. dohrni* Scudd (Pl. VIII. figs. 11 and 12).

Of the allied genus *Pyragropsis* Bor. (= *Propyragra* Burr), in *P. paraguayensis* Bor., the parameres are exactly the same in form, only a little smaller (Pl. VIII. fig. 13).

But in *P. thoracica* Serv. there is a well-marked difference; the

metaparameres are very much narrower, and almost perfectly crescent-shaped, the internal basal dilation being practically obsolete (Pl. VIII. fig. 14).

It is unfortunate that we have not got any record of the genitalia of *Pyragropsis tristani* Bor., type of that genus, since it may turn out that we may yet keep *Pyragropsis* and *Propyragra* distinct, one for the *Pyragra* and *P. paraguayensis* type of metaparameres, the other for the *P. thoracica* type.

It will be interesting, too, to see the form of the virga in this group.

In *Pyragra fuscata* Serv., *Pyragropsis thoracica* Serv., and *P. paraguayensis* Bor., the manubrium is short and transverse, well rounded, almost semi-circular.

Sub-family 8. Blandicinæ.

This imperfectly known sub-family is provisionally erected for the unique specimen in the Vienna Hofmuseum, which I have described under the name *Blandex solvendus*; it is simply labelled "South Africa." The relationship of this curious creature is still uncertain; there is something Pygidicranine in its appearance, especially in the style of coloration. The antennæ recall those of *Anatælia*, but the keels of the femora are obsolete, or almost, as also those of the elytra; the structure of the sternum agrees with that of *Anatælia* and *Challia*. I can detect no combs on the mesosternum, so it is a truly apterous species, although the elytra are free.

The genitalia are curious, and do not resemble at all closely those of any other species; the metaparameres are short and broad, and bilobed, like a finger and thumb; the straight and moderately long virga is quite simple, and not unlike that of the same organ in some *Pygidicraninæ*; but the fine dentition of the præputial sac is an unusual feature in the *Pygidicraninæ*. It is highly desirable that more material be found, so that the opisthomeres may be examined, and the presence or absence of gonapophyses in the female be determined (Pl. IX. fig. 1).

Family LABIDURIDÆ.

My limitation of this group differs but little from that of Zacher. I propose to remove the *Allostethinæ* to the *Pygidicranidæ*, as we have seen, and to include the *Apachyidæ*, suppressing the sub-order *Paradermaptera* of Verhoeff. As Zacher has shown, the genitalia and general structure are suggestive of Labidurine affinities; the two most striking features, the extreme flattening of the body, and the fusion of the opisthomeres into a squamopy-

gidium, are seen also in the *Platylabiinæ* and the genus *Gonolabina* respectively.

Table of Sub-families.*

1. Body not strongly flattened.
    2. Prosternum narrowed posteriorly; metaparameres short and broad; virga dilated; manubrium triangular; squamopygidium as in *Gonolabina*; virga inflated, and with spiral structure . . . . . . 1. Esphalmeninæ.
    2, 2. Prosternum not narrowed posteriorly; (squamopygidium never formed).
        3. Manubrium very long, narrow at base, dilated at apex; virga, when present, simple; metaparameres lanceolate or dilated . . . . 2. Psalinæ.
        3, 3. Manubrium short, never more than twice as long as broad, and never dilated at the apex.
            4. Antennæ with 25–35 segments; prosternum constricted posteriorly; meso- and metasterna as broad as long; virga serpentine, with vesicle and spiral structure; manubrium rectangular; pygidium quite six times as long as metapygidium 3. Labidurinæ.
            4, 4. Antennæ with 10–15 segments; prosternum nearly parallel-sided; meso- and metasterna transverse; pygidium only about twice as long as metapygidium.
                5. Postfrontal and median sutures of head very distinct, præfrontal absent; virga with vesicle and spiral armature . 4. Parisolabinæ.
                5, 5. Postfrontal and median sutures obsolete, præfrontal distinct; virga not inflated, and no spiral armature . 5. Brachylabinæ.

1, 1. Body strongly flattened.
    2. No squamopygidium formed . . . . 6. Platylabiinæ.
    2, 2. Squamopygidium in both sexes . . . 7. Apachyinæ.

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* The *Landicinæ* were included after the above table was drafted; circumstances have prevented the modification necessary to admit this new sub-family, but it is so well characterized that it can be at once discriminated.

Sub-family 1. Esphalmeninæ.

This family is always poorly represented in collections, and very few entomologists have seen each of the half-dozen or so known species. Unfortunately, although I have representation of every known species in my collection, they are all old and dry, and in the case of the rarer sorts, I prefer to wait for eventual fresh material, rather than break up the very fragile and valuable specimen to obtain not really satisfactory results.

It is a very well characterized sub-family, unaccountably confused by so acute an observer as Verhoeff, as well as previous writers, myself included, with the Oriental genus *Gonolabis* Burr, the only feature in common being the total apterousness and posterior dilation of the abdomen.

Zacher figures the genitalia of *Esphalmenus lativentris* Phil., the type species, and I add that of the South African *E. peringueyi* Borm.; Zacher very naturally questions the ranging of this isolated South African species into an essentially Andean genus, for all other known species are confined to the western coast of South America, from Patagonia to Ecuador, but there is no doubt whatever that *E. peringueyi* is a genuine *Esphalmenus* (Pl. IX. fig. 2). Apart from the external characters, the form of the prosternum, abdomen, tarsi, pygidium, and the genitalia are of the same general form as in *E. lativentris*.

In both the metaparameres are short, broad and bilobed; the virga is short, the greater proportion being occupied by the dilated vesicle, with "Spiralversteifung." The form of the metaparameres is only slightly different in the two species, as a comparison of Zacher's figure and of mine will show. The virga is essentially the same, Zacher's "Endrohr" being the virga proper, with spiral structure; at the base in *E. lativentris* there is a small acute chitin-plate. In my mount of *E. peringueyi*, which is taken from a very old and dry specimen, I cannot detect such a plate, but I observe a free, narrow chitin-plate, as long as the whole virga, in one of the præputial sacs.

In *E. camposi* Bor. the manubrium is decidedly transverse, in the form of an obtuse-angled triangle.

In *Esphalmenus camposi* Bor. we find a peculiar development of the metaparameres.

I have unfortunately only old and dry specimens to examine, and consequently the armature of the præputial sacs and virga is very obscure (Pl. IX. fig. 3). I am just able to detect a short length of ejaculatory duct entering a very delicate inflated vesicle, which in turn seems to run through a horseshoe-shaped transverse bar, but I can see no trace of spiral structure; at the apex of the sacs there seems to be a broad dilated chitin-plate.

But the metaparameres are very remarkable; they are short, the inner margin straight, and outer margin rounded; the apical part of the inner margin is strongly dentate; four sharp teeth, one being bifid, are discernible. Running backwards from the apical tooth is a curved keel which terminates in a strong recurved crested tooth or acute lobe, directed posteriorly; from the base of this crested tooth there runs a branch of the keel, across the segment, connecting up with a slight longitudinal keel, which does not reach the edge of the segment. The appearance of this complex armature varies with the aspect, and though I have examined two specimens, I am unable to say if both pairs are exactly alike in detail; probably not. At least, in the figured specimen, the largest tooth of the right paramere is apically bifid, but I can see no such incision on the other side. This complex armature is very curious, and I have so far seen nothing like it in any other earwig.

The proparameres are dilated externally, and broad (Pl. IX. figs. 3 and 4).

Sub-family 2. Psalinæ.

As Zacher has observed, this group, which is a homogeneous and extensive one, offers the greatest difficulties to the taxonomist. The species are so numerous, and the number of new genera relatively so great, that it is more convenient to deal with it separately in a distinct paper.

Sub-family 3. Labidurinæ.

The genital armature in this group is characterized by the more or less parallel-sided, narrow, acute parameres, with long serpentine virga having a basal vesicle with spiral structure. The genitalia of the genus *Tomopygia* Burr has not yet been examined, but the other three genera can be arranged as follows: —

1. Metaparameres with epimerit at apex.	
2. Metaparameres rounded and slightly widened at the apex	1. *Labidura* Leach.
2, 2. Metaparameres lanceolate	2. *Forcipula* Bol.
1, 1. Metaparameres without epimerit, acuminate .	3. *Nala* Zacher.

In *Labidura* we may possibly find a means of defining as species some of the forms of *Labidura riparia* Pall., which at present I regard as variants of one highly plastic polymorphic species. Zacher figures the genitalia of *L. bicolor* Kirby, from Colombia, in which the metaparameres are broadly rounded at the apex. In the Indian *L. bengalensis* Dohrn the curvature is much more marked on the outer margin, and a small point is formed

at the apex on the inner margin, inside the epimerit. Further, Zacher states that the genitalia of *L. batesi* Kirby do not differ from those of *L. riparia*, but that the virga as well as the metaparameres of *L. bicolor* is quite distinct (Pl. IX. figs. 5 and 6).

At the same time we must remember that this is a highly plastic species, that the degree of variability of the genital armature is as yet uninvestigated, and that these organs may be nearly as variable as the external secondary sexual features.

In *Forcipula* the metaparameres are much narrower than in *Labidura*, and regularly acuminate, and the epimerit is prominent. Zacher figures *F. quadrispinosa* Dohrn, from Annam, and *F. pugnax*; in the latter the actual tip of the metaparamere is rounded. In *F. decolyi* Borm., from new Guinea, the epimerit is broadened in the middle, and the metaparameres are not acute. In *F. gariazzi* Bor. it is very much like that of *F. quadrispinosa* (Pl. IX. figs. 7 and 8).

In *Nala* the virga is shorter, and the metaparameres have no epimerit. They are rounded on the outside, and gradually acuminate in *N. lividipes*, but broad at the apex in *N. tenuicornis* Borm. In *N. nepalensis* Burr they are longer and more acute than in *N. lividipes* (Pl. IX. figs. 9 and 10).

In *Labidura* the metaparameres are more or less rounded at the apex, though the extreme is pointed, with a lanceolate epimerit. My mounts of *L. bengalensis* agree with Zacher's figure of *L. bicolor* Kirby; Zacher states that the genitalia of *L. batesi* scarcely differ from those of *L. riparia* Pall., but those of *L. bicolor* are clearly different. I can see no difference, and maintain my view that there is but one species of *Labidura*, namely *L. riparia* Pall., but that that is a highly plastic species, with numerous races and widely distributed varieties, in fact, incipient species.

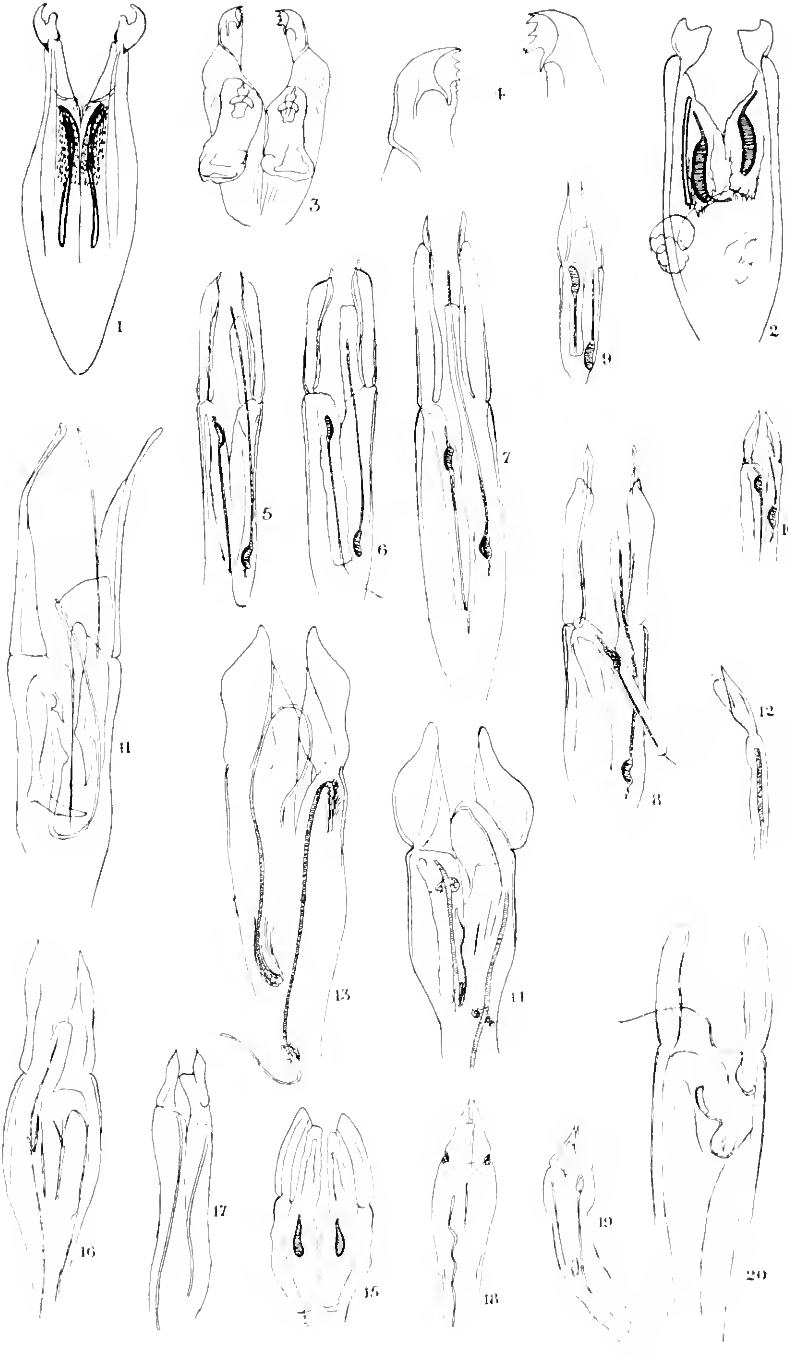
Zacher (p. 372) queries my identification of *F. quadrispinosa*, from Annam, on the grounds that the median tooth of the forceps described by Dohrn is represented by a mere thickening; surely he has realized by now the flexibility of the armature of these organs. I shall never be persuaded that a difference in size, shape, or position of the teeth of the forceps is a specific character.

EXPLANATION OF PLATE IX.

FIG.
1. *Blandex solvendus* Burr.
2. *Esphalmenus peringueyi* Borm.
3. *E. camposi* Bor.
4. Ditto, ditto.
5. *Labidura riparia* Pall. (Dongola).
6. *L. bengalensis* Dohrn.
7. *Forcipula gariazzi* Bor.
8. *F. decolyi* Borm.
9. *Nala nepalensis* Burr.
10. *N. lividipes* Duf.

FIG.

11. *Landex femoralis* Dohrn.
12. *Idolopsalis whymperi* Burr.
13. *I. riveti* Bor.
14. *I. andeana* Burr.
15. *Parisopsalis spryi* Burr.
16. *Antisolabis rouxi* Burr.
17. *A. transiens* Burr.
18. *Brachylabis canaca* Burr.
19. *B. trägårdhi* Burr.
20. *Apachyus beccurii* Dubr.



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Sub-family 4. LANDICINÆ.

Antennæ 12–15 segmentis, clavatis; prosternum postice constrictum; mesosternum postice rotundatum; metasternum in lobum subrotundatum productum; manubrium parallelum, duplo longius quam latius, rectangulare; metaparameres longissimi, angusti, subparalleli, symettrici; virga longa, gracilis, haud spiralis; preputialis laminis chitinosis instructus.

Antennæ with 12 to 15 segments, the third long and cylindrical, the rest strongly clavate; prosternum subparallel, constricted posteriorly; mesosternum rounded posteriorly; metasternum produced into a more or less rounded lobe; manubrium parallel-sided, rectangular, about twice as long as broad; metaparameres very long and narrow, asymmetrical; virga very long and slender; preputial sacs with chitin-plates; tarsi slender, third segment about half as long as the first.

Genus *Landex* g. n.

This genus is erected for "*Psalis*" *femoralis* Dohrn, from Southern India and Ceylon, and probably the Malayan *P. plebeja* Dohrn will fall here too. The former may be taken as the type; the manubrium is peculiar, recalling that of *Labidura riparia*, but much longer; the genital armature is quite peculiar; the metaparameres are unusually long and narrow, curved at the tips, and asymmetrically curved, in a manner recalling the forceps of *Anisolabis maritima*; the virga is long and slender, and simple, with no spiral structure, rather broad in the basal third; its entire length is about double that of the præputial sack, which is armed with a leg-shaped chitin-plate (Pl. IX. fig. 11).

This armature does not resemble that of any other species known to me; in the form of the manubrium,* *Landex* differs sharply from the *Psalinæ*, and in the genitalia it differs from everything else; the manubrium is suggestive of relationship with *Labidura*, in which genus Dohrn originally placed it. The presence of chitin complex plates in the præputial sac is suggestive of an approach towards the *Labiidæ*, as also the narrowness and asymmetry of the metaparameres.

The ninth sternite of the male of *Landex femoralis* has a prominent keel, produced into a sharp point, which seems hitherto to have been overlooked.

* Trans. Ent. Soc. London, 1915, p. 271, pl. xxxi. fig. 15.

Sub-family 5. Parisolabinæ.

Zacher figures the genitalia of *Parisolabis novæ-zeelandiæ* Verh., in which the metaparameres are short, broad, and pointed; the virga is not very long, has an inflated vesicle, and a spiral structure.

In *Parisopsalis spryi* Burr the metaparameres are narrow, elongate, curved in the form of a crescent, and rounded at the apex. The virga is short and broad, somewhat inflated towards the apex, with spiral structure (Pl. IX. fig. 15).

In *Idolopsalis riveti* Bor. the metaparameres have a Psalidine appearance. They are broad, narrowed but rounded at the tip, the outer margin sinuate, and a false inner margin; the virga long and coiled at the end, but the spiral structure is visible almost throughout the whole length; the basal vesicle is feebly marked, and reinforced by fibrous chitinous growth (Pl. IX. fig. 13).

In *I. andeana* Burr we have very similar structure; the metaparameres are broad in basal half, somewhat dilated, and narrowed in apical half, to a rounded tip. The virga is long, nearly straight, with spiral structure and a small chitinous reinforcement near the base (Pl. IX. fig. 14).

The metaparameres of the former resemble those of *Euborellia greeni* from the Shervaroys; those of the latter recall *Gonolabis picea.*

In *I. whymperi* the metaparameres are lanceolate, being broadest about the middle and acuminate at the tips; the virga is straight. My specimen is very defective; in fact, all my specimens of this genus are from very old and dry individuals (Pl. IX. fig. 12).

Sub-family 6. Brachylabinæ.

I am obliged to cross swords with my very esteemed colleague Dr. Zacher with some of his remarks under this heading. He finds fault with my placing of the *Brachylabinæ* as a sub-family of the *Labiduridæ,* yet he himself ranges them in his *Labiduriales,* which is the same thing. Again, from his remarks on pages 387 and 389, he implies that one character of the group is that the branches of the male forceps are contiguous at the base, but in the majority of species they are remote. He explains the apparent inconsistencies of Blanchard's figure of *Forficula* (now *Brachylabis*) *chilensis* by the assumption that the drawing illustrates a different creature from the one described, but my recollection of the figure, which I have not had occasion to see recently, is that it has a decidedly Brachylabine appearance, and the apparent inconsistencies may be more readily explained by careless draughtsmanship.

Zacher figures the genitalia of *Leptisolabis usambarana* Verh., and of *Isolabis braueri* Verh., presumably from Verhoeff's original material, but without any reference in the text. He also shows

the organs of a Paraguayan species which he refers to *Ctenisolabis fernandezi* Bor., which Dr. Borelli considers, *in litt.*, to be a mis-identification of the well-known Paraguayan species known as *C. nigra*, which may or may not be identical with the original *B. nigra* of Scudder, from Peru. In all these figures Zacher shows a rather broad, short, apically acute metaparamere. In all the virga is many times longer than the metaparameres, with what appears to be narrow chitin-plates, shaded to look like "Spiralversteifung," and apparently a few denticulate areas in the præputial sacs.

I am able to illustrate three species recently described by me from New Caledonia: *Brachylabis canaca*, *Antisolabis rouxi*, and *A. transiens*. In the first two the metaparameres are of the same general type as those figured by Zacher, but longer; the virga, discernible on one side only, is simple, gently sinuate, about twice as long as the metaparameres, with no sign of chitin-plates (Pl. IX. figs. 16 and 18). In the third the metaparameres are still longer, with both margins sinuate, the virga single, straight, and very long, with no marked passage from ejaculatory duct to virga, no vesicle, and no trace of spiral structures, but a pair of narrow chitin rods in the præputial sac, which are probably what Zacher figures in the case of *I. braueri* and *L. usambarana*. Both my specimens are very feebly chitinized. *B. trägårdhi* Burr, from Natal, is also figured (Pl. IX. fig. 19).

Sub-family 7. Apachyidæ.

Zacher considers this group an offshoot of the *Labiduridæ*, and as the genitalia offer no very specialized characteristics, I drop the sub-order *Paradermaptera*, and treat the *Apachyidæ* as a family of the *Protodermaptera*.

I have so far only examined the male genitalia of *Apachyus beccarii*, which closely resembles those of *A. depressus* as figured by Zacher. The curious squamopygidium loses somewhat of importance when we remember that a similar feature is characteristic of *Gonolabina*, in the *Esphalmeninæ*. In fact, I consider that the *Apachyidæ* are not more remote from the *Labidurinæ* than are the *Esphalmeninæ*. My specimens show an inflated basal vesicle, and though Zacher refers to its non-existence, his figure clearly shows a small one (Pl. IX. fig. 20).

Sub-family 8. Platylabiinæ.

This sub-family, containing a single monomorphic genus, has been dealt with by Zacher.

SUMMARY OF CURRENT RESEARCHES

RELATING TO

ZOOLOGY AND BOTANY

(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),

MICROSCOPY, ETC.*

ZOOLOGY.

VERTEBRATA.

a. Embryology.†

Entrance of Spermatozoon into the Egg.‡—Jacques Loeb discusses the nature of the conditions which determine or prevent the entrance of the spermatozoon into the egg. If eggs of *Strongylocentrotus purpuratus* or *Arbacia* are induced to develop by the methods of artificial parthenogenesis, a spermatozoon can enter the egg or an individual blastomere. This shows that the block caused by the entrance of a spermatozoon must be due to a change not necessarily identical with that inducing the development of the egg. The block to the entrance of heterogeneous sperm is rapidly reversible, and confined to the surface of the egg or the spermatozoon, or both. In the case of the ovum of *Strongylocentrotus* and the sperm of *Arbacia* (and many similar instances), the specific block can be overcome by a slight increase in the alkalinity of the sea-water. The change brought about by the hyperalkaline sea-water is rapidly reversible.

It has been shown that when the unfertilized eggs of *S. purpuratus* are treated for a couple of hours with hypertonic sea-water, those of certain females develop parthenogenetically, while those of others do not. Perhaps those that develop parthenogenetically are those in which the hypertonic sea-water can induce the cortical changes underlying the membrane formation. Whatever the nature of the individual difference may be, the eggs of *S. purpuratus* that have been induced to develop into larvæ by a hypertonic solution can be fertilized with sperm while

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, etc., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so called, but also those dealing with Evolution, Development, Reproduction, and allied subjects.

‡ Amer. Nat., xlix. (1915) pp. 257–85.

they are segmenting. A membrane forms around the fertilized blastomere, and the segmenting eggs perish rapidly. The changes underlying development do not in themselves form a block. The eggs of *S. purpuratus* in which artificial membrane formation has been induced by butyric acid, can also be fertilized subsequently with sperm. In the case of *Arbacia*, membrane formation may be induced in unfertilized ova by treatment with butyric acid, and such ova disintegrate rapidly. But the subsequent fertilization of such eggs by sperm saves their lives and makes them develop.

The egg of *S. purpuratus* can be fertilized by the sperm of *Asterias* while both eggs and sperm are in a hyperalkaline solution. When the eggs are put from the hyperalkaline sea-water, free from sperm, into the normal sea-water with very motile sperm of *Asterias*, there is no fertilization. When put back into hyperalkaline sea-water containing *Asterias* sperm they will be fertilized rapidly. In other words, the effect of the alkali is rapidly reversible. It is confined to the surface of the cells. The block caused by the entrance of a sperm is of a similar nature—some rapid alteration of a physical property of the surface.

Loeb goes on to inquire whether the motility of the spermatozoon plays no other rôle than to bring the spermatozoon so close to the surface of the egg that surface-tension phenomena can engulf the spermatozoon into the egg. The spermatozoon cannot enter the egg unless certain physical conditions at the boundaries of egg, spermatozoon, and surrounding solution are right. The impact of the spermatozoon against the egg is a prerequisite for the process of fertilization. A sea-urchin spermatozoon becomes more active when it comes near an egg of its own species, and the immature eggs of *Asterina* activate the sperm of the sea-urchin *S. franciscanus* as powerfully as is done by the mature eggs of the sea-urchins *S. purpuratus* and *S. franciscanus*, which shows that there is no strict specificity. Yet the spermatozoa of *Asterias ochracea* and *Asterina* are activated strongly by the (immature) eggs of their own species, and only slightly by the eggs of *S. purpuratus*. So there is some degree of specificity. It must be remembered that all these experiments are made in a NaCl solution, and that it requires a stronger influence to activate the spermatozoa of a starfish than those of a sea-urchin. Loeb believes that the activating effect of the egg upon the spermatozoon is of the greatest importance for fertilization in nature, and that the degree of specificity which exists (although it is far from absolute) is a means of preventing hybridization. It seems probable that the eggs, which are naturally fertilized in water, are fertilized almost instantly after they are shed. There appears to be simultaneously shedding of the germ-cells in the two sexes of Echinoderms. The specificity of the egg activates the sperm of the same species much more quickly than that of a foreign species, and hybridization is averted.

The vibrations of the spermatozoon's flagellum assist boring into the egg ; they may be needed also to make the spermatozoon stick to the surface of the egg until other forces come into play. No proof for the existence of a positive chemotropism of the sea-urchin sperm for the eggs of the same species has yet been given. There is sometimes

a process of sperm-agglutination or cluster-formation when a number of rapidly-moving spermatozoa (of sea-urchins and certain Annelids) strike one another. Perhaps there is agglutination of the spermatozoon to the egg.

According to Lillie, fertilization consists in the combination of the spermatozoon with a molecule of "fertilizin" in the egg, whereby the fertilizin molecule undergoes a change in the other end, and this change causes the egg to develop. The fertilizin is thus an amboceptor in the sense of Ehrlich's side-chain theory (Egg–Fertilizin–Spermatozoon). Loeb criticizes this speculation. He holds that no adequate proof has been offered thus far for the connexion between the power of an egg of being fertilized by sperm, and its power of causing a cluster-formation of the sperm. It is difficult to see why such a relation should exist, since sperm-agglutination can only inhibit the entrance of the spermatozoon into the egg.

Relation of Spermatozoa to Electrolytes.*—James Gray calls attention to the fact that ripe spermatozoa of *Luidia*, which remain motionless in sea-water, are activated by the addition of a few drops of $\frac{N}{10}$ NaOH, and proceed to fertilize the eggs. The spermatozoa do not move in acid sea-water. The cessation of movement is due to the absence of hydroxyl-ion in the surrounding medium. By increasing the alkalinity movement is induced. Cessation of movement in too alkaline sea-water causes agglutination, and this cannot be reversed by adding acid. The fact that the effect of acid can be removed by the addition of alkali suggests the possibility that the movement of spermatozoa is dependent upon the electromotive properties of the cell and its medium.

When an electric current is passed through a neutral suspension of spermatozoa in cane-sugar, the sperm travels rapidly to the positive pole, where it accumulates (as Lillie observed in the case of the frog); round the negative pole, however, the spermatozoa become exceedingly active, which is due to the liberation of alkali. In a faintly acid solution of cane-sugar, no migration occurs to the positive pole, and no activation at the negative pole. The spermatozoa form a retiform aggregation throughout the solution. It is concluded that motile spermatozoa possess a negative charge on their surface, and that this charge is lost in the presence of free hydrogen ions.

If a drop or two of very weak solution of cerous chloride is added to a suspension of *Arbacia* sperm, the spermatozoa become intensely active and form active clumps. Experiments with neodymium nitrate gave similar results. As the effect of these trivalent positive ions is removed by means of sodium nitrate, it is suggested that the trivalent ions affect the spermatozoa by virtue of their electrical charge.

Lillie found that sea-water which had been in contact with unfertilized eggs and extracted "agglutin" from them had a marked effect on spermatozoa, greatly increasing their activity, aggregating them, and agglutinating them.

* Quart. Journ. Micr. Sci., lxi. (1915) pp. 119–26.

It would thus appear that the behaviour of spermatozoa towards "agglutin" is identical with their behaviour towards a trivalent kat-ion. The nature of the electric charges upon the surface of the gametes may play an important rôle in the behaviour of these cells.

In an interesting note the question is raised whether the limit of migration of *Luidia* is fixed by the alkalinity of the sea-water.

Spermatogenesis in Domestic Chicken.*—Alice M. Boring and Raymond Pearl discuss the significance of the odd chromosome in the spermatogenesis. In the Black Langshan Breed it has been reported by Guyer that an X-chromosome goes into one-half of the secondary spermatocytes, thus giving rise to two kinds of spermatozoa, half with X and half without. If this X-chromosome is assumed to be a sex chromosome, as in so many forms, the male bird, according to Guyer's account, must be heterozygous in regard to sex.

In the Barred Plymouth Rock breed there is no convincing evidence of the existence of a sex chromosome. In 11·82 p.c. of first spermatocytes and 3·06 p.c. of second spermatocytes, there is a piece of chromatin similar to that called an X-chromosome by Guyer in Langshan males. This is not to be regarded as an X-chromosome in Barred Plymouth Rocks, for it is present in spermatocytes of both orders; and it varies in shape, size, and number. In no single cell is it of such a shape or size, or in such a position, that it could not readily be interpreted as anything else than an X-chromosome. A statistical study of Barred Plymouth Rock cells in comparison with those of the Hemipterous insect *Philænus spumarius* shows that it is present in too few primary spermatocytes and in too many secondary spermatocytes, or vice versa. It is still present in too few cells, if it should be interpreted as one of those rare cases where the odd chromosome divides in either the first or the second spermatocyte division.

Interstitial Cells in Chicken's Testes.†—T. B. Reeves calls attention to Miss Boring's conclusion that there are no interstitial cells present at any time in the testes of chicken from one day to twelve months old, and to the work of J. des Cilleuls who found interstitial cells from the thirteenth day onwards. Reeves examined the testes from cocks five and a half, nine, and eighteen months old, and found interstitial cells in all the stages examined.

Size Dimorphism in Spermatozoa from Single Testes.‡—Charles Zeleny and E. C. Faust have made a large number of measurements of the sperm-heads in various insects, and also in a frog, a Chelonian, and three mammals. The plotted curves of variation in size indicate strongly the existence of size dimorphism in most of the species studied. Thirty-three separate determinations were made, with an average of about 523 measurements for each determination, and a total of 17.252 for the whole.

In nearly all cases there were two high points or modes in the

* Journ. Exper. Zool., xvi. (1914) pp. 53–82 (6 pls.).
† Anat. Record, ix. (1915) pp. 383–6 (3 figs.).
‡ Journ. Exper. Zool., xviii. (1915) pp. 187–240 (43 figs.).

distribution curve indicating that the population of spermatozoa is made up of two separate groups. A comparison of the degree of separation of these modes with the expected degree as derived from a calculation based on the chromosomal histories shows in general a striking correspondence. The general conclusion is drawn that two size groups may be distinguished in many of the species which show chromosomal differences in spermatogenesis, and that the size difference is based on the difference in chromosomal content. If the hypothesis that the chromosomal differences are of sex-determining value is true, it follows that the larger spermatozoa differ from the smaller ones in sex determination. While the method seems competent to yield a conclusive general result, no attempt is made to minimize the many possible sources of error liable to come into individual determinations.

Inheritance of Fecundity.* — Raymond Pearl finds that there is a marked difference in average egg-production per bird of Barred Plymouth Rock pullets of the Maine Agricultural Station strain at the present time as compared with what obtained during the period of simple mass-selection for this character of fecundity. The difference in question is in the direction of a substantially higher mean production at the present time, when tested on flocks of large size. The increase in flock average productivity is most pronounced in respect to the winter production, the laying cycle to which especial attention has been given in the breeding. The cause of this increase in flock productivity appears, with a degree of probability which amounts nearly to certainty, to be that the method of breeding the stock now followed is more closely in accord with the mode of inheritance of fecundity than was the simple mass-selection practised in the earlier period. The conclusion indicated is that high fecundity is a sex-linked character, for which the female is is heterozygous. This conclusion has also been reached by practical poultrymen in their breeding operations.

Sex-ratio in Pigeons.† — Leon J. Cole and W. F. Kirkpatrick report the results of their experiments on sex-ratios in pigeons, together with observations on the laying, incubation, and hatching of the eggs. The birds used were mostly what are known as Long-faced Tumblers (both Clean Legged and Muffed), but the stock was derived from various sources, and included some Parlor Tumbler stock. The normal ratio of the sexes of pigeons hatched is 105 males to 100 females. The death-rate of squabs is especially high for the first two or three days after hatching, and at about ten to fifteen days of age. When the two squabs are of distinctly different size before the banding age (ten to fifteen days) the larger squab is more often a male than a female. The death-rate for the two sexes, in bisexual broods, is essentially equal. There is a higher mortality of females in early adult ages, and this, along with the higher proportion of males hatched, may result in an excess of males in adult populations. The number of unisexual broods ("both males" or "both females") is very slightly greater than that of bisexual broods.

* Amer. Nat., xlix. (1915) pp. 306–17.
† Bull. 162, Agric. Exper. Station, Rhode Island, 1915, pp. 463–510.

There is no tendency for the first eggs to produce exclusively males, and the second eggs females. As regards determination of sex, the facts seem to indicate that sex in pigeons is determined according to the laws of chance.

The mean time of laying of the first egg is about 5 p.m., and of the second egg about 1 p.m. of the second day following. The mean interval is practically forty-four hours, but it decreases progressively in the months from February to July inclusive. The mean time of hatching of the first egg is 16·5 days after the laying of the second. The mean time of hatching of the second egg is seventeen days after it is laid. The time from laying to hatching of the first egg is nearly a day and a half longer than for the second egg. This is probably because the first egg receives very little incubation until the second is laid.

When the eggs do not hatch they are seldom abandoned at the end of the normal period of incubation, but the birds sit on for an average of six days after the normal period, making the mean total time of incubation (when the eggs do not hatch) twenty-three days after the laying of the second egg. This continuance of incubation beyond the normal time under such circumstances constitutes "a factor of safety" in the incubating instinct. The number of days required for the young to hatch being variable, "nature, rather than drawing the line too closely, makes allowance for the extremes." A pair of Mourning Doves (*Zenaidura macroura carolinensis*) continued to sit on substituted eggs for four days after their own had hatched in an incubator.

Growth of Body and Organs of Albino Rats fed with Lipoid-free Ration.*—Shinkishi Hatai finds that lipoid-free ration diminishes the normal rate of growth. The weight of the central nervous system is reduced by about 2 p.c. The percentage of water in the longer bones is increased by 5 p.c. The testes showed not only a deficiency of 44 p.c. as a result of six months of the lipoid-free diet, but there is also a clear indication of actual loss of weight (23 p.c.), i.e. there is marked atrophy. The ovaries were reduced in weight by 17·4 p.c., but growth was continuous and there was no loss of gland. A curious result is noted, among many others, that on the lipoid-free diet, as well as in various forms of underfeeding, and after long-continued exercise, the rats become remarkably resistant to the lung infection which appears in the controls.

Weight of Rats at Birth.†—Helen Dean King finds that the body weight of albino rats at birth differs considerably in different strains. The weights for the males range from 2·6–7·5 grm.; those for the females vary between 2·7 grm. and 5·9 grm. As a rule, in any litter individuals of the same sex are practically of the same size and body weight.

The body weight depends upon a number of factors that are more or less closely related. 1. The offspring of older females tend to be

* Anat. Record, ix. (1915) pp. 1–20.
† Anat. Record, ix. (1915) pp. 213–31.

heavier. 2. The mothers in good condition have heavier offspring. 3. The heavier mothers have heavier offspring, for they are older and in better condition. 4. Individuals in small litters weigh more at birth than do individuals in large litters. 5. The weight increases in later litters, probably because the mothers are older. 6. It is probable that the prolongation of the gestation period for even one day materially increases the weight of the young at birth.

Influence of Temperature on Development of a Mendelian Character.*—Mildred A. Hoge has found that selection aimed at producing races of *Drosophila* possessing high or low numbers of teeth in the sex-comb resulted in the isolation of races with high and low numbers of teeth; but in neither race was the number of teeth of the average individual higher or lower than the extreme variants in a wild stock.

During the course of the selection a mutation, involving reduplications in the legs, appeared. The origin of the mutation was probably not determined in any way by the selection, for repeated selection in a new line was not followed by a similar character. The new character was found to be due to a sex-linked factor, the location of which in the sex-chromosome is close to that of the factor for vermilion eyes.

The extra legs sometimes acted as a dominant, and sometimes as a recessive character, and flies homozygous for the reduplicating factor were often perfectly normal. The reduplications were found to be due to some extent to the temperature, as a low temperature, maintained throughout the larval life, was necessary for the production of a large proportion of abnormal flies. Only flies carrying the reduplicating factor, however, could be thus affected by a lowering of the temperature.

The extra legs were of a variety of types, and the number of extra parts in a single leg varied from one to four. A definite relation in symmetry was found to exist between the normal and the supernumerary parts. It is apparent that the extra parts are formed by one or more bifurcations, and it is suggested that reduplications in other animals may be explained in a similar manner.

Ovarian Factor in Recurrence of Œstrous Cycle.†—F. H. A. Marshall and J. G. Runciman find that the occurrence of "heat" (pro-œstrum and œstrus) in dogs does not depend upon the presence of mature or nearly mature Graafian follicles in the ovaries. It is equally evident that it is not dependent upon corpora lutea.

It must be supposed, therefore, that the ovarian factor in the recurrence of "heat" resides in some other ovarian element or combination of elements. The ovarian interstitial cells are possibly concerned in the process, but cyclical changes in the condition of these cells have not so far been observed in the dog's ovaries.

In any case, the view which has generally been maintained, that the ripening of the Graafian follicles and the onset of menstruation or of heat stand to one another in the relation of cause to effect, must be

* Journ. Exper. Zool., xviii. (1915) pp. 241–96 (5 pls.).
† Journ. Phys., xlix. (1914) pp. 17–22 (2 figs.).

finally abandoned. It is probable that both series of changes are effects of some more deep-seated ovarian phenomena.

Artificial Production of Spina bifida in Frog.*—W. M. Baldwin has sought by experimental methods to throw light on the familiar question whether the fertilized ovum is a composite organization of formative substances (or the chemical progenitors of primordia distributed in a definite way), or is a unicellular organism without pre-localized differentiated formative substances or primordia, but with the specific capacity of forming "ferments" and primordia at successive genetic stages. Recourse was had to ultra-violet rays of such a degree of intensity as to cause the disorganization of the cytoplasm in from one to thirty seconds, and of such a degree of concentration as to influence a limited surface.

The killing of a small localized area of the yolk hemisphere or of the region of the equator of the frog's egg produces invariably the condition of spina bifida in the embryo. It is further shown that the formative substances of the neural tube do not lie either in the yolk hemisphere or along the equator of the frog's egg, but are wholly restricted to the pigmented half of the egg. They attain their definitive positions by a process of backward migration, the rate of which is synchronous with that of the backward progression of the dorsal lip of the blastopore. The destructive action of the ultra-violet rays results in an upset of the synchronism of the two factors, i.e. differentiation of the neural primordia and approximation of the lips. The former proceeds at its normal tempo, while the latter is retarded. Consequently, the former, always restricted to the pigmented hemisphere, come to lie along the equator and are later carried towards the median plane by the subsequent approximation of the lips, but the half-tubes, having already differentiated into whole tubes, do not subsequently fuse. The causative forces in the production of spina bifida seem referable to an upset of a specific substance in the egg.

Spawning of Black Bass.†—B. A. Bensley, in an interesting report on the fishes of Georgian Bay, gives an account of the spawning of *Micropterus dolomieu*. The spawning is usually during June. The male makes the nest—a shallow basin, 15 or 20 in. in diameter, fanned out of the weedy or pebbly bottom, and fully cleaned of all debris. The bottom of the nest may be of clean rock or pebbles, but is more often of short stems of the aquatic plant *Eriocaulon*, which forms an ideal surface for the attachment of the eggs. The male swims out into the deeper water and drives a selected female before him. She swims into the nest and extrudes the eggs, a few (10 to 12) at a time. The male sheds milt at corresponding intervals. There are marked differences in the coloration of the two sexes at the spawning time. After the spawning, which lasts for a half-hour to three hours, the female leaves the nest or is driven forth. The male mounts guard, fanning the eggs from time to time, and driving off

* Anat. Record, ix. (1915) pp. 365–81 (16 figs.).

† Contributions Canadian Biology. Department Fisheries, Ottawa, Fasciculus ii. (1915), pp. 1–51 (2 pls. and 6 figs.).

intruders. The eggs hatch in a few days, and the young (very conspicuous pure black objects) are watched over by the male for a few days more.

Early Monotreme Egg.*—J. T. Wilson and J. P. Hill describe an early egg of *Ornithorhynchus*, and discuss their previous interpretation of the "primitive knot," making some amendments in their conclusions. An interesting photomicrograph is given of the embryonic area.

Primordial Germ-cells of Chick.†—Charles H. Swift finds that the primordial germ-cells arise anterior and antero-lateral to the embryo in a specialized region of germ-cell endoderm just at the margin of the area pellucida. This region has roughly the shape of a crescent, and the germ-cells arise during the primitive streak stage and until the embryo has about three somites. The concavity of this crescent is towards the embryo and the horns extend caudalwards on either side.

Owing to the late appearance of the mesoderm in this region, the primordial germ-cells are at first in the space between endoderm and ectoderm. Subsequently, by amœboid movements, they enter the mesoderm and the incipient blood-vessels of the mesoderm. They are at first carried by their own movement, and later by that of the blood, to all parts of the embryo and vascular area. They remain generally distributed in this way until the embryo has about twenty somites.

In embryos with about twenty to twenty-two pairs of somites, the primordial germ-cells, while generally distributed in the blood-vessels, are becoming relatively more numerous in the vessels of the splanchnic mesoderm. This may be a real increase, probably of a chemotactic nature, exerted in the region of the future gonad. Or it may be more apparent than real, a degeneration of some having occurred elsewhere. At this period the great majority of the cells are found in the vessels, but a few, chiefly in the splanchnic mesoderm, are present in the tissues. In some cases they are present in the wall of the vessel, as if fixed in the act of the leaving the vessel for the tissues.

In embryos with about twenty-three to twenty-five pairs of somites the majority of the primordial germ-cells are found in the mesodermal tissue of the splanchnic mesoderm near the angle of the cœlom. The embryo with twenty-five somites is the oldest in which germ-cells are found in the vessels.

Hitherto the youngest bird-embryos in which the primordial cells have been described are those with twenty-two to twenty-three somites. Swift has carried back the history to the primitive streak stage.

In embryos possessing about twenty-six to twenty-nine somites the primordial germ-cells are found in the splanchnic mesoderm near the radix mesenterii. In embryos with thirty to thirty-three somites the primordial germ-cells are in the radix mesenterii and cœlomic epithelium on both sides of the cœlomic angle. They remain in this position until the formation of the gonad begins, when they gradually pass into that organ.

* Quart. Journ. Micr. Sci., lxi. (1915) pp. 15–25 (1 pl. and 1 fig.).
† Amer. Journ. Anat., xv. (1914) pp. 483–516 (15 figs.).

Earliest Blood-vessels in Man.*—J. L. Bremer finds that in the human embryo the earliest blood-vessels arise separately in the yolk-sac and in the body-stalk, by multiple primordia. The primordia in the body-stalk (and perhaps also in the yolk-sac) are funnel-shaped ingrowths of the surface mesothelium, which is present as a definite layer only on the two areas mentioned. By partial fusion of the walls of an ingrowth a portion of the cœlom, still bordered by mesothelium, may be cut off as a separate cavity, lying deep within the substance of the body-stalk.

The endothelium seems to arise either (*a*) by a delamination from the walls of such a detached portion of the cœlom, or (*b*) by direct extension, in the form of an angioblast cord, from the mesothelial ingrowth. From the endothelium, by whatever method developed, further extension is by means of the angioblast cords, which grow apparently through the surrounding mesoderm.

The angioblast cords are apparently solid cords of cells, connected end to end or in small groups, running between the processes of the surrounding mesenchymal cells, when these are present, often touching them, without however actually fusing with them. The cords tend to form nets by anastomosis of larger mesh than the mesenchymal net, and angiocysts by vacuolization wherever space is given. They are usually sharply defined from the surrounding tissue, and may show an extra-intimal space.

True blood-islands may occasionally arise by the multiplication of the cells of the mesothelial ingrowths, or scattered blood-corpuscles may arise singly within these ingrowths. Extension within the limit of the areas covered by the mesothelium is achieved by confluence of the detached portions of the cœlom, or union of the cords; the result is a net comprising the various vascular units. Extension into the chorion, where the mesothelial layer is absent in the early stages, appears to be by direct centrifugal growth of the angioblast cords, without the addition of new elements from the surrounding mesenchyma. The possibility that similar, but later, ingrowths from the mesothelium of the intra-embryonic cœlom may give rise to intra-embryonic vessels, should be borne in mind in the study of such vessels, whether hæmal or lymphatic.

Development of Posterior Lymph-heart in Chick.†—Randolph West finds that the lymphatic plexus which later enters into the formation of the posterior lymph-heart arises by the confluence of independent mesenchymal spaces which connect secondarily with the veins. These spaces are bounded at first by mesenchymal cells which later become flattened to form an endothelium. Both in the endothelial lymphatic walls and the adjacent mesenchyme there is an active hæmopöesis, the products of which reach the general circulation via the lymphatic plexus. Attention may be drawn to three very fine coloured reconstructions of the caudal vessels of a chick.

Development of Thymus in Pig.‡—J. A. Badertscher finds that the thymus of the pig has an ectodermal-endodermal origin. The

* Amer. Journ. Anat., xvi. (1914) pp. 447–75 (11 figs.).
† Amer. Journ. Anat., xvii. (1915) pp. 403–36 (14 figs.).
‡ Amer. Journ. Anat., xvii. (1915) pp. 317–36 (2 pls.).

respective origin of each segment is described. (1) The superficial thymus, which is a derivative of the cervical vesicle, has a purely ectodermal origin. (2) The connecting band is also a derivative of the cervical vesicle, and has, therefore, a purely ectodermal origin. In most embryos it persists to birth, but it may be absent on both sides or on one side. (3) The thymus head, in which is lodged the parathyroid III, is formed by a fusion of a portion of the cervical vesicle to the anterior end of the epithelial diverticulum derived from the third pharyngeal pouch. It has, therefore, an ectodermal-endodermal origin. (4) The intermediary and cervico-thoracic cords, and the mid-cervical and thoracic segments, are derived wholly from the epithelial diverticulum of the third pharyngeal pouch, and have, therefore, a purely endodermal origin.

Development of Thymus in Pig.*—J. A. Badertscher comes to the following conclusions in regard to the histogenesis of the thymus in the pig. The lymphocytes first present in the thymus are all large lymphocytes, and have migrated into it from the mesenchyme. The numerous small round cells of the thymus are formed by the repeated division of the large lymphocytes, which thus become small, and also by their own proliferation. From the source and structure of the small round cells it is inferred that they are small lymphocytes and identical with the small lymphocytes of the blood. The thymus, therefore, may well be considered as a source of some of the small lymphocytes found in the circulating blood. The reticulum of the thymus is of epithelial origin, and is formed passively by its meshes becoming filled with lymphocytes which separate the nodal nuclei farther apart, and thus greatly attenuate the protoplasmic processes of the syncytium. The Hassall's corpuscles are of epithelial origin. The free red blood-cells and eosinophile cells found in the interlobular septa and the thymic lobules are derived from lymphocytes *in situ*. It is difficult to determine whether or not any of the erythrocytes formed in the thymus enter the circulating blood. Some undergo degeneration, and the products of disintegration of those existing in the form of eosinophile granules are taken up by the lymphocytes, which thus become transformed into eosinophile leucocytes. It was impossible to trace the origin of all the eosinophile granules in the eosinophile cells directly to degenerated red blood-cells, but a relationship exists between the disappearance of the free erythrocytes and the formation of free eosinophile cells.

The histogenesis of the thymus may be divided into three epochs. 1. The purely epithelial epoch extends from the origin of an outpocketing from the third pharyngeal pouch and the formation of the cervical vesicle to the appearance of the first lymphocytes in the thymus.

2. Second, there is the epoch of lymphocyte infiltration and lymphocyte proliferation and the formation of the reticulum. The infiltration of the thymus by extrathymic lymphocytes from the mesenchyme surrounding it begins in embryos from 25–30 mm. in length, and probably continues up to stages 180 mm. in length, while their proliferation in the thymus undoubtedly continues after birth. The

* Amer. Journ. Anat., xvii. (1915) pp. 437–92 (3 pls.).

reticulum, which according to the nature of its development is formed gradually, differentiates into the cortex and the medulla in developmental stages 65–75 mm. in length, and is fully formed in embryos 180 mm. in length.

3. Third, there is the epoch of the formation of red blood-cells and the development of granular cells. An occasional red blood-cell is found in the thymic lobules shortly after lymphocytes are found in them. They are, however, first present in appreciably large numbers in stages of about 55 mm. in length, and are most numerous in the thymus of full-term embryos. In the interlobular septa of the thymus the greatest number occurs in stages of about 125 mm. in length, while only a few are found in embryos of 180 mm. in length to full term. Eosinophile cells were first found in thymic lobules of a 42 mm. embryo, but occur first in appreciably large numbers in embryos of about 180 mm. in length, and are most numerous in the parenchyma of the thymus of full-term embryos. In the interlobular septa they are seldom found in embryos from 65–83 mm. in length; they occur first in appreciably large numbers in the septa of embryos of about 125 mm. in length, and are most numerous in embryos 165–185 mm. long, but are still present in the septa in full-term embryos.

Experiments on White Mice.*—Frances B. Sumner gives an account of his studies (1906–1911) of environmental influence, heredity, correlation and growth in the white mouse. About 2300 animals were measured. The parent generation of mice was reared, usually from birth, in two rooms differing widely in temperature and humidity. In some cases a second generation was reared in the two rooms. Sumner found certain differences between the mean measurements of lots which were reared in the cold-room and in the warm-room. As regard the tail and the foot these differences were considerable in amount and of absolutely certain statistical significance. They were always in favour of the warm-room animals. The cold-room animals were chiefly modified. A modification in ear length, at first apparent, turned out to be slight in amount and of inconstant occurrence.

Comparison of seventy-four warm-room and fifty-three cold-room male mice, killed before the withdrawal of the temperature differences, showed that the latter had an appreciably greater quantity of hair. Comparison of about fifty mature females, killed nearly six months after the discontinuance of the temperature differences, showed more hair in the warm-room lot. Temperature did not appear to have any constant effect upon body weight.

In the offspring of two sets of modified mice, born and reared in a common room, those of warm-room parentage had, on the average, a greater weight and greater length of tail, foot, and ear than those of cold-room parentage, when animals of the same body length were compared. Four lots of about two hundred each were measured. In one of the four lots, born nearly five months after the discontinuance of the temperature differences, determination of hair weight showed a greater quantity in the warm-room series. While the offspring of cold-

* Journ. Exper. Zool., xviii. (1915) pp. 325–432 (17 figs.).

room and warm-room mice have been found to differ from one another in various characteristic respects, provided that the parents were influenced by the temperature conditions from a very early age, it does not appear that these differences in the offspring are entirely parallel to those produced in the parents. There is no proof that temperature conditions which acted on the pregnant mothers determined modifications among the offspring.

Some correlations were determined. Even when animals of the same history and the same size are considered; individuals with longer tails have, as a rule, longer ears and feet, are heavier, and have more hair.

Certain phenomena of growth were noted. After the initial retardation of the cold-room animals in respect to tail length, the tails grew faster, both relatively and absolutely, than those of the warm-room animals. In both lots, the shorter tails grew, on the average, faster than the longer ones. There is a tendency toward compensation in growth, such as was observed by Minot for the weight of guinea-pigs.

Effect of Castration on Growth.*—Shinkishi Hatai has experimented with albino rays to test the effect of the removal of the sex glands in either sex, which he calls gonadectomy. The use of this term as applicable to both sexes leaves castration to apply to the operation on the male, while that on the female is designated by spaying. Five operations were performed: total gonadectomy (castration and spaying), partial gonadectomy (semi-castration and semi-spaying), ligature of the spermatic cord, removal of one ovary followed by an isolation of the other from the uterus, and the isolation of both ovaries from the uterus.

The body lengths were slightly less in all the rats operated on, except the spayed females, in which the body lengths were distinctly greater. The tail length with respect to the body length tends to be slightly longer in the castrated males. The body weight in respect to body length is greater in nearly all rats operated on, but especially in the spayed rats. In castrated and spayed rats the bones (femur, tibia, fibula, humerus, radius, and ulna) tend to be very slightly longer and heavier than in the corresponding controls, and the percentage of water in the bones slightly higher. No characteristic response was observed for the central nervous system.

In the semi-spayed series the compensatory growth of the remaining ovary is almost perfect as it attains nearly twice its normal size. In the semi-castrated the remaining testis showed an increase of 14 p.c., but this may be solely in the interstitial tissue. The isolated ovaries survived and grew as if they had been connected with the uterus. In the case of isolation of the ovary followed by semi-spaying, the remaining isolated ovary hypertrophies in the same manner as that of the semi-spayed rat. The ligation of the spermatic cord may cause a complete atrophy of the testes and alterations of somatic characters similar to those in castrated rats. No definite conclusions could be drawn in reference to the thyroid gland, which is very variable in weight.

* Journ. Exper. Zool., xviii. (1915) pp. 1–67.

In castrates the supra-renals show an increase, in spayed rats a decrease. When the spermatic cords are ligatured (and the testis absorbed) the supra-renals show reactions similar to those following castration. The thymus increases to about twice its size after gonadectomy. It seems not only to delay its normal involutionary process but actually to increase in weight. The weight of the hypophysis is increased on the average by 50 p.c. after removal of the testis or after ligature of the spermatic cord (and absorption of the testis). On the other hand, spaying produced only a slight increase (about 8 p.c. on the average).

After removal of the sex glands and compensatory growth of the hypophysis, there is no overgrowth of the body or obesity. But these responses appear when the enlargement of the hypophysis does not occur—in the spayed rats, for example. In the semi-spayed and semi-castrated, neither enlargement of the hypophysis nor obesity occurs, for the enlargement of the remaining gonad enables it to furnish the normal amount of gonadine. The total removal of the gonads tends to increase the resemblance between the two sexes, or it may be said that gonadectomy favours the production of the secondary sex-characters of the opposite sex.

Hybridization among Ducks and Pheasants.*—John C. Philipps has made a number of interesting crosses, e.g. pintail and mallard, *Anas tristis* and mallard, Black East India duck and mallard, Lady Amherst Pheasant and Golden Pheasant. Many characters apparently clear-cut and antagonistic do not segregate clearly. It is almost certain that the ordinary sub-species of the ornithologist is very far from being a unit variation. In the wild forms experimented with, both sexes carry the characters of the opposite sex through several generations without an additional "dose" of the character in question, but it is admitted that sex-linked inheritance may be a feature in domestic races. A study of species hybrids in birds will satisfy anyone that on almost every feather region the minutest details of feather pattern and colour show the influence of both parental races. Only in sterile hybrids, or hybrids between distantly related forms, do we find hybrids that are at all puzzling in appearance, as Ghigi has pointed out. In crossing two species, only one of which is sex dimorphic, a more primitive type of male plumage is seen in the hybrids and in the back crosses. In the mallard, a condition closely resembling eclipse or summer plumage is brought out by crosses with the black duck.

Inheritance in Teleost Hybrids.†—H. H. Newman has made reciprocal crosses between species of the genera *Fundulus* and *Cyprinodon*, and between species of the genus *Fundulus*, four of the hybridizations resulting in more or less viable larvæ. The most successful crosses are those between *F. diaphanus* and *F. heteroclitus*, in spite of the fact that the former is a fresh-water species and the latter a marine species. It seems generally true that in crosses between very closely related species

* Journ. Exper. Zool., xviii. (1915) pp. 69–112 9 pls.).
† Journ. Exper. Zool., xvi. (1914) pp. 447–99 (5 pls.).

the rate of development is accelerated, while in those between distantly related species development is retarded, but not necessarily in direct proportion to the heterogeneity of the cross. Although foreign sperm may materially alter the rate of early development, it plays no rôle in the heredity of the organism until embryonic differentiation is well under way.

A study of the inheritance of pigment in hybrids of species of *Fundulus* leads to the conclusion that all the well-known modes of inheritance are illustrated—that characterized by dominance or even hyperdominance, that commonly called blended or intermediate, and that usually called mosaic or particulate. There is another mode distinct from any of these. It is still an open question whether these types could be successfully reduced to an orthodox Mendelian basis, were the unit factors involved all analysed out.

It seems as if any Teleost spermatozoon might play a rôle in cleavage equivalent to that of agents that are successful in artificial parthenogenesis, but that only certain kinds of sperm, that can successfully co-operate with the egg-nucleus in its hereditary activities, are capable of working out a complete ontogeny.

The idea expressed by Moenkhaus that success in the development of Teleost crosses is a function of the phylogenetic relationship of the parents cannot be upheld. For there is a marked difference between the developmental success of reciprocal hybrids, and success in the development of hybrids produced by crossing different orders of Teleosts is not seldom greater than that attained by hybrids between different families of the same order, or even between different genera of the same family.

Hybridizing Teleosts.* — H. H. Newman has made ninety-three crosses among fourteen species of Woods Hole Teleosts—species of *Fundulus*, *Cyprinodon*, *Gasterosteus*, *Scomber*, *Tautoga*, and other genera. He discusses the heterogenic crosses between members of different orders or families. In seventeen cases he got some embryos with a circulation: in sixteen cases he got larvæ. There is as much developmental success among the heterogenic crosses as among some homogenic crosses (between different genera of a family or species of a genus). In general, there seems to be no primary correlation between the degree of success in development and the nearness of relationship of the species cross. The factors determining the relative success in the development of hybrids are associated with the amount, density, and specific composition of the yolk and with the hardiness of the egg. The rate of development seems unimportant.

In many cases definite paternal characters are seen in the hybrid, which goes to disprove Loeb's view that the sperm in heterogenic hybridization plays only the rôle of initiating development. But the most successful embryos that develop to hatching are predominantly maternal, perhaps only apparently so. Monsters are common, all of them interpretable as due to retardation of development through the disharmonious interaction of foreign germ-plasms. The main blocks occur

* Journ. Exper. Zool., xviii. (1915) pp. 511–76 (11 figs.).

at critical stages, such as gastrulation, concrescence, head differentiation, the establishment of the circulation. These crises probably represent the apices of curves of morphogenetic activity, when the metabolic rhythm is at its height. A lowering of the rate of metabolism affects these processes more profoundly than it would processes associated with a low developmental tonus.

Many cases of independently differentiating tissues were observed, chief among which are chromatophores, heart, and fins. These structures continue to develop when isolated from their normal environment. De-differentiation of the more highly differentiated parts occurs readily even while the less differentiated parts continue to grow. General death occurs slowly, and some tissues are particularly resistant. Chromatophores go on to their definitive state even when the tissues of the embryonic body are reduced to a generalized mass of cells.

Behaviour of Chromatin in Teleost Hybrids.*—Margaret Morris finds that in the cross *Fundulus* (female) and *Ctenolabrus* (male) the germ-nuclei are closely applied to each other, but form chromosomes for the first division without having fused. The chromosomes of the first cleavage spindle are of two types, which correspond respectively to those seen in the normally fertilized eggs of the two species. Although the foreign chromosomes lag somewhat behind the others in going to the poles, they are all finally included in the daughter-nuclei of the two-cell stage. The two types of chromosomes reappear in the spindle of the second cleavage, and can be distinguished throughout the development, which was followed as far as the twelve-hour stage. In the twelve-hour stage large cells with irregular nuclei are found, which represent the beginning of disturbances, which afterwards lead to the abnormality or death of the larvæ. There was no evidence of elimination of the paternal chromatin at any stage.

b. Histology.

Independent Life of Cells.†—S. von Schumacher gives an account of some of the recent work on the independent life and individuality of cells. Although division of labour has occurred in Metazoa, there is often a considerable retention of autonomy. The power of independent life is most marked in cells which live in fluid media, such as the spermatozoa and the leucocytes. The spermatozoa received by a queen bee from the drone may live in the receptaculum seminis for at least three years. The spermatozoa of the salamander may live for two years in Siebold's sacs, blind diverticula of the cloacal wall of the female. The spermatozoa of the bat remain in the uterus of the female from autumn to spring, when fertilization occurs. Grosser found the uterus of *Vesperugo noctula* full of sperms at the end of August. Human spermatozoa may survive for eight and a half days, and those of the guinea-pig for eleven days, in a refrigerator.

* Journ. Exper. Zool., xvi. (1914) pp. 501–21 (5 pls.).

† Die Individualität der Zelle. Jena, 1914, pp. 1–12. (Heft 10, vol. ii. of Sammlung Anat. Physiol. Vorträge, ed. by Gaupp and Trendelenburg.)

Similarly as to leucocytes, Ranvier found those of the frog moving in a moist chamber after eight days, and Recklinghausen till the twenty-first day. And as to red blood-corpuscles, Cornu found evidence that those of the dog could survive in extracted blood kept on ice for eight to ten days.

Many observations have been made on ciliated epithelium, since its evidence of life is obvious. Engelmann found the cilia moving in the tracheal epithelium of man three days after death. Grawitz observed ciliation at the end of the seventh day after excision; Busse after eighteen days. Becker observed ciliary movement in cells of the epididymis of the ox eight days after excision. Valentin observed ciliary activity for weeks after death in the tortoise. Zielonko placed pieces of mucous membrane from the frog's mouth into a dorsal lymph sac, and observed ciliation after five months. Schumacher has confirmed this, finding that isolated epithelial cells may live for weeks, separately or in multicellular masses, in the dorsal lymph sacs.

A piece of human skin may be grafted on after being kept for twenty-four to forty-eight hours in salt solution. Brewer has stated the limit at thirty-six hours, but Ljunggren found that a week could be reached in ascites-fluid. Thiersch found that a skin-graft was not killed by the low temperature of ethyl-chloride, and Lusk succeeded with a piece that seemed as dry as parchment. Ollier found a piece of rabbit's periosteum living after twenty-four hours. Grawitz succeeded in grafting the cornea of the hare after nine to twelve days at low temperature, followed by a soaking in frog's lymph.

The heart of the tortoise removed from the body may be made to beat for hours after four days, or after a longer period if it be washed internally with suitable salt solution. The heart of a boy who died of inflammation of the lungs was removed by Kuliabko twenty hours after death, and was washed internally with Locke's fluid. After about twenty minutes weak beats were induced, which lasted for about an hour. Slight pulsations of ventricles and auricles may sometimes be observed in the human heart even thirty hours after death. There are great individual differences.

Roux began the remarkable experiments known as "explantation," the culture of excised tissues or parts in suitable media. Leo Loeb showed that epithelial tissue could grow in agar or blood-serum. The methods have been greatly improved by Harrison, who cultivated pieces of frog embryo in drops of lymph in a hollow slide. He succeeded in keeping fragments living for four weeks or so, and observed differentiation in progress. Thus cells taken from the myotomes became typical striped muscle, and often showed contractility. Cells from the primordium of the nervous system showed amœboid movement, and the outgrowth of an axis-cylinder process into the coagulated lymph. The process arises actively like a pseudopodium, and retains amœboid movement at the distal end. Burrows used blood-plasma instead of lymph, and worked with embryonic tissue of frog and chick. The work of Carrel and others is referred to. Carrel alternated a period of visible activity in the culture-medium with a period of latent life in Ringer's solution and at low temperature. In this way he kept embryonic tissue

alive for three months and fragments of heart muscle capable of pulsating after three months. The term culture should only be used when the fragments form fresh cells characteristic of the kind of tissue.

Amœboid movements of cells in explanted tissue have been frequently observed. They may be seen creeping along fibrin threads. Carrel and Burrows showed that the fibrin threads could be replaced by silk threads. Explanted cells of heart muscle show rhythmic contractions for a long time, which seems to corroborate the myogenic theory of cardiac activity. The ingestion of foreign bodies by explanted cells was observed by Lambert, who used *Lycopodium* powder with explanted spleen from an embryo chick. Giant cells were in this case seen to arise from the coalescence of large mononuclear migratory cells, an important observation, since the origin of these giant cells has been obscure.

Metabolic processes may also be proved in explanted tissue. The formation of anti-bodies has been demonstrated, and the appearance of fat globules, which may be a sign of the slow dying of the cells.

The demonstration of growth processes is more difficult, especially since a similitude of growth may be brought about by swelling, deformation, and migration of cells. Not even the observation of mitotic figures is sufficient, for the mitosis might have begun before the explanation. An increase in the number of mitotic figures is convincing. It is the general experience that mitoses are not particularly frequent in explanted tissue. Carrel has proved growth in explanted embryonic tissue by counting the cells. But many observers have been unsuccessful in proving genuine growth, and are inclined to deny its reality.

A further question arises whether the new-formed cells, if there are such, are characteristic of the tissue in question. Burrows found that the new-formed cells developed from embryonic heart-muscle showed rhythmic contractions, but most observers record that it is the connective tissue that grows. The new-formed cells are usually stellate. spindle-shaped, or roundish ; they show amœboid movements ; and they grow radially into the nutritive medium.

According to Hada, the new-formed cells in explanted tissue do not show the specific features of the original tissue ; it is difficult to say whether they are epithelial or connective ; their growth is without order. Weil also says that the new-formed cells do not show the function or arrangement of the mother-cells. Champy found multiplication by mitosis followed by de-differentiation of elements. There is a relapse into an indifferent condition.

Schumacher's general conclusion is that there is little warrant for speaking of a culture of differentiated tissues or organs after explantation. It is important, however, that the viability of isolated cells has been demonstrated, and their multiplication in some cases. The continued differentiation of some embryonic cells has also been securely proved.

Mitochondria in Tissue Cultures.*—Margaret R. Lewis and Warren H. Lewis find that the cells of fragments of embryonic tissue from the chick show finely granular cytoplasm and nucleus, almost homogeneous

* Amer. Journ. Anat., xvii. (1915) pp. 339–401 (26 figs.).

in appearance, without sign of reticular or alveolar structure. Mitochondria are present in all the cells of these growths as slightly refractive, large or small granules, rods and threads. They can be followed and studied for hours in the living unstained cell. The mitochondria may be scattered throughout the cytoplasm, or they may be located around the nucleus or around the idiozome. Any one mitochondrium may change its position in relation to another, or to the cell as a whole. They may scatter or condense. During mitosis they become more evenly scattered, except in the spindle area, where they are usually absent. Their shape is very variable, and one may assume fifteen or twenty shapes in ten minutes. They may divide or fuse; they vary greatly in size; they appear to increase or decrease in size without fusion or division. They vary in number from two or three to over two hundred, and are not constant for any one kind of cell.

Degenerating mitochondria become first a series of granules: later the granules become vesicles, and then separate into a number of small finely granular rings which stain like the cytoplasm rather than like mitochondria. They are more or less scattered in an indifferent manner during mitosis, and about one-half the quantity goes to each daughter-cell.

Mitochondria are extremely plastic, but they are not specific. One type changes into another. They are distinguishable from other granules by their staining reactions. They are greatly increased in number and quantity in giant cells. Mitochondria appear to arise in the cytoplasm, and to be used up by cellular activity. They are, in all probability, bodies connected with the metabolism of the cell.

Mitochondria in Vertebrate Nerve-cells.*—E. V. Cowdry has studied the comparative distribution of mitochondria in spinal ganglion cells in Vertebrates. They occur in the spinal ganglion cells of man, monkey, guinea-pig, white rat, pigeon, snake, turtle, frog, and *Necturus*. They are characterized by the constancy of their structure, distribution, relative amount and microchemical properties. There is a reciprocal relation between the amount of mitochondria and lipoid granules in these cells. The coagulability of the Nissl substance, on fixation, increases progressively in the gradation which exists between the small and the large spinal ganglion cells of man, monkey, guinea-pig and white rat.

Histogenesis of Selachian Liver.†—Richard E. Scammon gives a detailed account of the histogenesis of the Selachian liver. His material was chiefly obtained from *Squalus acanthias*, but reference was made to skate, torpedo, and other types for comparison. He describes the development of the hepatic parenchyma, the minor bile ducts, the hepatic mesenchyma, and the hepatic sinusoids. The adult liver is divergent from the common Vertebrate type in the great accumulation of fat in the hepatic cells, in the comparatively slight development of

* Amer. Journ. Anat., xvii. (1915) pp. 1–28 (3 pls.).
† Amer. Journ. Anat., xvii. (1915) pp. 245–336 (7 pls.).

the bile-duct system, and in the absence of lobulation of the kind generally found in higher Vertebrates. But these peculiarities which distinguish the Selachian liver are not manifested until a comparatively late stage in the development. In earlier stages the characters common to the liver in all Vertebrates, but which are often masked or modified in higher forms, are shown with unusual clearness. It is with them that the memoir has mostly to do.

Structural Unit of Pig's Pancreas.*—George W. Corner defines the structural unit of an organ as the smallest part of it which is regularly repeated in a similar way throughout, and which contains the elemental constituents of the organ; that is to say (if it is a gland of external secretion), gland substance, duct, and blood-vessels. The length of a blood capillary defines the size of the unit. Ludwig and his pupils showed that all the capillaries connecting the terminal tips of the arteries and veins are of the same length in any one organ.

The pancreas of the adult pig is formed by the repetition 20,000 to 30,000 times of a structural unit about one millimeter in diameter. The unit is more clearly outlined in the fœtus than in the adult. Its size is limited to the area of supply of one arteriole. Pressure of fluid injected into the main duct of the pancreas is equally distributed to all the units. By presumption, the reverse is true, that is, all the units deliver their secretion against equal pressure.

Corner confirms the statement of Laguesse and others that the early pancreatic ducts are plexiform. The main ducts of the pig's pancreas and its branches arise by dilatation of capillary ducts in the primitive plexus, in a manner similar to the origin of arteries and veins from capillaries.

Mast Leucocytes of Rabbit.†—A. R. Ringoen finds that the bone-marrow of the rabbit contains true mast myelocytes with basophil granules, in addition to other granular leucocytes. The granules of the mast leucocytes are differentiated gradually out of the basophil cytoplasm of mononuclear cells. As they increase in number, the nucleus changes shape and becomes polymorphous. Fully differentiated mononuclear mast leucocytes are never found in the blood or marrow of the adult rabbit. They show no evidence whatever of degeneration. Their granules are formed by progressive differentiation of the cytoplasm. The hæmatogenous mast cells of the rabbit form a distinct and independent line of granulocytes, which is in no way related to the eosinophil or special leucocytes, except through the non-granular parent-cell of the bone-marrow.

Macrophages of Mammals.‡—Herbert M. Evans defines the macrophages as those mononuclear cells, wherever they may be, lining vascular channels, resident in connective tissues, or entirely free, whose proto-

* Amer. Journ. Anat., xvi. (1914) pp. 207–36 (19 figs.).
† Anat. Record, ix. (1915) pp. 233–42.
‡ Amer. Journ. Phys., xxxvii. (1915) pp. 243–58.

plasm constitutes a physical system characterized above all by its response to finely particulate matter. In the case of particles of ordinary microscopic dimensions, this response (phagocytosis) is a behaviour shared equally with the polymorphonuclear elements of the blood. But towards the very much finer ultra-microscopic particles, the macrophages react in a practically specific way, "drinking" them in, as it were, and storing them either as free coagula in their protoplasm, or as the inhabitants of watery vacuoles, where they oscillate in ceaseless Brownian movement. They are able to store substances of importance to the organism, and their action in this capacity appears to obey the principle of a physiological balance. Only in cases where the local or general content in the substance is very high do they load with it, and they liberate their content in an impoverished fluid. In all processes connected with tissue destruction the macrophages house the complex chemical bodies set free, and so become the great cells finally so evident to the eye.

Mechanism of Mitosis.*—Marcus Hartog replies to criticisms which Baltzer and Meek have brought against his theory of mitosis. His general position is thus summarized. The processes, dynamic and other, of the normally dividing cell may be analyzed as follows: 1. Such as are known in the inorganic world: (*a*) osmosis and turgor, found in the enlargement of the spindle; (*b*) traction and tension of the viscid threads of the spindle; (*c*) fluid resistance deforming the "disceding" chromosomes; (*d*) solution and "desolution"; (*e*) surface tension; and (*f*) electric phenomena.

2. Such as are known to occur elsewhere in living plasma, but which have not been adequately referred to physico-chemical phenomena: (*a*) growth of chromatin substance and of chromatin fibres; (*b*) protoplasmic movement, and especially that which is expressed in the elongation of the spindle; (*c*) the transverse division of the elongated viscid bodies with increase of their surface, occurring in the chromatin granules at right angles to the chromosomes in which they lie, and in the final division of the cell; (*d*) the fusion and apparent loss of identity of the daughter-chromosomes, and the reconstitution of the daughter-nuclei.

3. Mitokinetism, a force analogous to electrostatic force, manifested in the karyokinetic field, in the splitting of the chromosomes, and in the "discession" of their daughter-segments.

4. Such as are found to have no clear equivalent elsewhere: the resolution of the nuclear network into a definite number of chromosomes, the orderly sequence of events, the different phenomena leading up by different roads to the same end. The process is incompatible with reference to any single dominating force such as osmosis (Leduc), or changes in electrostatic potential due to colloids (Lillie, Mann, Gallardo). The author's answer to criticisms carries further his exposition of the fundamental physical and geometrical considerations on which the mitokinetism explanation rests.

* Arch. Entwickl., xl. (1914) pp. 33–64 (16 figs.).

c. General.

Marine Ecology.*—R. Southern discusses the various communities of animals on the floor of the sea in the Clare Island area. Numerous habitats are distinguished: sub-terrestrial mud, with small Nematodes and Oligochæts, and such molluscs as *Paludestrina stagnalis* and *Phytia myosotis*; brackish estuarine mud, with *Nereis diversicolor*, etc.; estuarine mud, with Zostera, with *Anemonia sulcata*, *Esperiopsis fucorum*, *Gibbula cineraria*, and species of *Rissoa* attached to the leaves, with many Crustaceans and the pipe-fish swimming about, with a rich fauna among the roots, including numerous Polychæts, such as *Macrochæta clavicornis* and *Polyophthalmus pictus*; estuarine mud, with Lithothamnion, with the characteristic *Gibbula magus*, and such forms as *Scoloplos armiger*, *Porcellana longicornis*, *Acmæa virginea*, and *Bittium reticulatum*; estuarine mud, without Zostera or Lithothamnion, with *Amphuira chiajii*, *Ophiothrix fragilis*, *Nephthys hombergi*, *Aricia cuvieri*, *Terebellides strœmii*, *Notomastus latericeus*, *Phascolosoma procerum*, and *Acera bullata* as characteristic species; coastal mud (not represented in the area); abyssal mud or ooze (beginning to appear at 300 to 400 fathoms); sub-terrestrial sand, with few animals save the sand-hoppers *Talitrus saltator* and *Orchestia gammarellus*, "which often occur in vast numbers, so that the noise of their bodies falling on the sand is like that made by a heavy shower of rain"; sand, with Zostera, with *Nereis cultrifera*, *Scoloplos armiger*, *Cirratulus tentaculatus*, and many other Polychæts, as also *Synapta inhærens*; littoral clean sand, without Zostera, with species that burrow deeply into the sand, such as *Arenicola marina*; sub-littoral (sheltered) sand, without Zostera and with few shells, with *Ficulina ficus*, *Antennularia antennina*, *Antedon bifida*, *Aphrodite aculeata*, etc., as characteristic species; sub-littoral clean sand, without Zostera, with many shells, with *Metridium dianthus*, *Ophiocoma nigra*, *Pandalus montagui*, Chitons, Nudibranchs, and *Lepadogaster bimaculatus*; coastal green sand, with a large fauna; muddy estuarine gravel, with Zostera, with a mixed association; muddy estuarine gravel, with Lithothamnion, with a mixed association; muddy estuarine gravel, without Zostera or Lithothamnion, with a rich fauna; coastal sandy gravel, with large number of *Polygordius lacteus* and *Pectunculus glycimeris*; coastal shelly gravel; coastal gravel, with Lithothamnion; the sub-terrestrial rocky zone, with insects, mites, acorn-shells, periwinkles, etc.; the rocky brackish-water seaweed zone, with animals exposed on rocks, hidden under stones, in crevices, etc.; the Laminaria zone, with *Helcion pellucida*, etc.; the zone of red seaweeds; the coastal rough ground; and the abyssal rough ground (not represented in the area).

The author takes a survey of the associations of animals found in the littoral and sub-littoral areas. The chief characteristics of the littoral fauna of Clare Island are the presence of species that thrive in exposed conditions, or require water of a high degree of purity and salinity, with equable conditions of temperature; and, on the other

* Proc. R. Irish Acad., xxxi. (1915) Clare Island Survey, pt. 67, pp. 1–110 (2 maps).

hand, the absence of certain species which are generally found living in sheltered conditions where muddy beaches and Zostera beds occur, where the salinity is affected by the entrance of streams and the temperature shows great fluctuations. A few of the characteristic features of the shore fauna are: 1. The abundant representation of twelve species of calcareous sponges. 2. The variety and small size of many sponges. 3. The absence between tide-marks of certain sponges found in that zone on the mainland. 4. The abundance of anemones and the presence of such forms as *Sagartia venusta*, *Corynactis viridis*, *Depastrum cyathiforme*, *Haliclystus auricula*, *Lucernaria campanulata*, and *Caryophyllia smithii*. 5. The presence of large numbers of *Strongylocentrotus lividus* and *Asterina gibbosa*, which are characteristic of exposed situations. 6. The large numbers of the Molluscs *Hermæa dendritica* and *Elysia viridis*, correlated with the abundance of their food-plant *Codium tomentosum*, and the absence of Molluscs like *Gibbula magus*, *Acera bullata*, *Mactra subtruncata*, which thrive in a more sheltered habitat. And (7) the absence of the Mollusc *Trochocochlea linea*, which occurs not far off. The Clare Island littoral and sub-littoral fauna is compared with that in some other similar areas.

Present-day de Novo Origin of Living Organisms.*—H. Charlton Bastian refers to the incredulity expressed in regard to his demonstrations of "archebiosis." It has been supposed that the organisms that appear on the slides have not come from the sterilized tubes, but from a dirty pipette or slide. He points out that this objection can be disposed of. It has also been suggested that the supposed living organisms are either simulacra or dead organisms surviving after the sterilization. This objection can also be answered. Moreover, tyrosine comes to the veteran observer's aid, for a small quantity of a very dilute solution causes the living organisms that may be present to grow and multiply freely. "Before the tyrosine the organisms were mostly very small and not too numerous, having often to be very carefully searched out; while after the influence of the tyrosine there were no longer any difficulties of this kind, or indeed any room for still maintaining a sceptical attitude on the ground that what are to be found in my tubes are either dead organisms or mere simulacra: the unmistakable growth and multiplication of the organisms negatives all such suppositions." "Mere simulacra or dead organisms may be not altogether absent; but with the help of the tyrosine it has been positively shown that the tubes contain crowds of living organisms of different kinds."

Hormone Theory of Transmission of Modifications.†—J. T. Cunningham argues in support of the theory that stimuli involved in the use of an organ caused hypertrophy in the part affected, and that in the course of generations the tendency to this hypertrophy was transmitted to the gametes. The hormone theory explains how such transmission may be effected. The hypertrophied part gives off chemical

* Proc. R. Soc. Med., June 1915, pp. 1–12 (8 figs.).
† Rep. British Assoc. Australian Meeting, 1915, pp. 419–20.

substances or hormones which circulate through the body, and acting on the gametes stimulate those parts of them which are destined to develop the same parts in the next generation. Secondary sexual characters, such as antlers and mammary glands, are supposed to have been produced, as modifications, at the time when the gonads were giving off their hormones, and thus the tendency, which is inherited, is to develop these modifications in the presence of those hormones, and not otherwise.

Phosphorous Content in Different Types of Animals.*—Hilda Kincaid finds from analysis of the exoskeleton in each class of Invertebrates that there is a steady increase in the phosphorus content as we ascend the evolutionary scale. It is never at any time large in Invertebrates, for most of the framework in lower animals consists of $CaCO_3$, while that of higher animals consists of $Ca_3(PO_4)_2$. In the endoskeleton of Vertebrates there is a sudden jump in the phosphorus content, which remains practically the same through the group. Analyses showed that the phosphorus content of nerve tissue and muscle tissue has a surprising uniformity throughout the whole animal kingdom.

Circulation Rate in Man.†—Walter M. Boothby brings forward experimental evidence showing that the circulation rate increases progressively with the oxygen consumption per minute in a manner corresponding to the increase in the total ventilation. The circulation of the blood is as carefully and delicately regulated in relation to the needs of the body as is the ventilation of the lungs. It is probable that the same regulatory factor—the hydrogen-ion concentration of the arterial blood—controls with equal delicacy the ventilation of the lungs and the rapidity of the circulation rate. Factors of nervous or psychic origin influence the circulation and pulmonary ventilation, but such influences are only temporary, and designed to meet sudden emergencies which require immediately in the muscles a greatly increased oxygen supply before a sufficient time could elapse for the chemical stimulus to be produced and to take effect.

An increase in the blood flow of 3·3 litres per minute, which is a doubling of the circulation rate, is caused by a rise in the total acidity of the blood corresponding to 2 mm. of carbon-dioxide, and this would correspond to a rise in the hydrogen-ion concentration of the arterial blood of about $0 \cdot 013 \times 10^{-7}$.

Colubrid Snake with Vertically Movable Maxillary Bone.‡—E. G. Boulenger finds that the solid-toothed Colubrid, *Xenodon merremi*, from Brazil and Paraguay, is able to erect and depress its fangs in a thoroughly viperine fashion. The portion of the maxilla bearing the fangs is much enlarged, and in a more or less vertical direction. It only remains for the last two teeth to be furnished with grooves to transform *Xenodon* into an Opisthoglyph, with the fangs situated below the pre-

* Rep. British Assoc., Australian Meeting, 1915, p. 554.
† Amer. Journ. Physiol., xxxvii. (1915) pp. 382–417.
‡ Proc. Zool. Soc., 1915, pp. 83–5 (1 fig.).

frontal. If *Xenodon* be compared with the least specialized of the vipers, *Causus*, it will be seen that a slight tilting up of the maxilla of *Xenodon*, with the loss of the few front teeth and a very slight change in the bone, is needed to bring about a condition similar both in structure and mechanism to that of vipers. The theory of the derivation of vipers from Proteroglyphs must be given up. G. A. Boulenger's view that they are derived from Opisthoglyphs is confirmed.

Urostyle and Spinal Cord of Frog.*—Geo. E. Nicholls notes that in young specimens of *Rana temporaria* the filum terminale of the spinal cord lies uncovered (except for connective tissue) upon the dorsal surface of the urostyle. In the adult *R. tigrina* he observed that the neural canal in the urostyle turned sharply up and extended quite to the dorsal margin, where it opens into a groove. In this open groove, extending approximately along the middle third of the dorsal surface of the urostylar crest, the end of the filum terminale lies. In some specimens the uncovered extremity of the neural canal is very short. Examination of other species of *Rana*, and of species of *Bufo* and *Hyla*, showed the emergence of the filum terminale. The condition described is probably normal for the Anura generally.

Diseased and Abnormal Conditions of Marine Fishes.†—James Johnstone refers first to piscine sarcomata, and in particular to multiple tumours in halibut and cod. The halibut was suffering from multiple melanotic sarcomata. These may have arisen by metastatic growth, fragments of an original tumour having been distributed through the lymph channels. But the general appearance rather suggested that the separate sarcomatous nodules had arisen *in situ* independently of one another, perhaps as the result of infection of some kind. The cod showed a large sarcomatous tumour undergoing profound autolytic degeneration. A multiple sarcoma of the mixed-cell type had grown to impossible dimensions. Deficient vascular supply (for the paucity of blood-vessels in such tumours is notable) had prevented the removal of products of katabolism, and had starved the cells. "Stewing in their own juice," the sarcomatous cells were killed and disintegrated into "mush." Accompanying this process of poisoning of the cells there was probably a process of true autolysis, or self-digestion of cells and capsules by their own enzymes. Products of cell excretion diffusing into the adjacent muscle substance affected the latter injuriously, so that degeneration of the fibres set in. The excretory products entering the blood stream of the fish produced marked emaciation. The end would probably have been the rupture of the tumour and the formation of a huge and fatal abscess.

Johnstone also describes a "hæmangioma" on the left eye of a stickleback (*Gasterosteus pungitius*). It is, perhaps, nearer a varicose vein or a hæmorrhoid, and was probably induced by some obstruction in the circulation. Another case dealt with was an ovarian cystadenoma

* Proc. Zool. Soc., 1915, pp. 239–42 (1 fig.).

† Rep. Lancashire Sea-Fisheries Laboratory, xxiii. (1915) pp. 18–56 (7 pls. and 7 figs.).

in a ling (*Molva molva*). Finally, the author describes a plaice without the left eye. There is not much evidence of a traumatic lesion. On the other hand, the absence could hardly be congenital, since the eye-muscles are almost normal and the optic nerve is considerably developed. It is suggested that a failure to form the lens in early development may have led to the abnormality. The bulbus oculi may have degenerated, while the optic nerve, having its trophic centre in the brain, persisted.

INVERTEBRATA.

Mollusca.

a. Cephalopoda.

Simulacra of Molluscan Shells.*—J. T. Cunningham discusses the simulacra of shells which Kappers produced in paraffin-wax. Kappers adopted the conclusion of Harting and Bedermann that the form and characters of Molluscan shells, as well as those of otoliths, egg-shells, and the skeletons of Foraminifera, Alcyonaria, and Echinoderma, are due to the aggregation of crystals of calcium salts formed within a colloid medium, the crystals being of a special kind called sphærocrystals or calcosphærites. Kappers maintained that paraffin-wax shares with calcium salts the property of forming sphærocrystals, and that the formation of crystals from a solution takes place in essentially the same way as in the solidification of a molten mass.

According to Cunningham the form and markings of the simulacra are not to be explained by any effect of crystallization, but were due, as in the case of Molluscan shells, to the successive addition of accretions in a particular direction. He poured molten paraffin-wax into water and obtained all sorts of simulacra.

Large prismatic crystals are formed when the cooling is slow, and they assume a stellate arrangement where there is most freedom of movement, i.e. near or at the free surface, as on a glass slide, or at the surface of a block, or floating shell-like mass. When the cooling was rapid, as at the surface in contact with water or in contact with the metal of a mould, neither large crystals nor stellate arrangement occurred; the structure is more compact, apparently because the wax becomes solid at numerous closely crowded points at the same time, and crystals if formed at all are very minute. In no case did Cunningham observe crystals having any approximation to a spherical form. The form and markings of Molluscan shells are not determined by the form and behaviour of the crystals of which their inorganic part is composed, but by the conditions of the mantle. The only resemblances between the real shells and their wax counterparts, is that they are both formed by successive accretions to the edge: the marks of the boundaries of these accretions are due, in the case of the wax, to interruptions of the flow by cooling of the lower layer and surface tension, in the case of the real shell, to "waves" of growth of the causes of which we are quite ignorant.

* Proc. Zool. Soc., 1915, pp. 225–34 (5 figs.).

Arthropoda.

α. Insecta.

Structure of Rat-flea.*—E. A. Minchin describes some of the structural details which he has observed in *Ceratophyllus fasciatus* Bosc. in the course of many dissections. He describes in detail the method used, which takes advantage of the adhesion of the soft parts to the cover-glass. The nervous system is different in the two sexes, the male having seven free abdominal ganglia, as against six in the female. There is also a difference in the arrangement of the nerve-stems given off from the hindmost ganglion-mass. The salivary glands of the larva differ greatly, both in size and in complication of parts, from those of the adult flea. In the more or less omnivorous larva, which feeds largely on the fæces of the rat and on dirt and debris of all kinds, the salivary glands are larger and with greater secreting activity. The glands of the adult, whose secretion probably keeps the blood from coagulating, contain microbes which perhaps cause the itching after the bite. The genitalia of the male exhibit a singular complication of parts, but can be readily mounted as an entire preparation from testes to penis. An account is given of the reproductive system in both sexes. Attention is called to the presence of stellate muscle-cells forming a beautiful and very delicate muscular network on the wall of the œsophagus, such as also occurs on the "crop," or "sucking-stomach" of the tsetse-fly, and on the crop of the house-fly. Perhaps the ancestors of fleas had a crop, of which the network of stellate muscle-cells on the œsophagus is a residue.

Abdominal Hairs in Bombycidæ.†—Leopoldo Chinaglia describes the hairs of a tuft on the posterior abdominal segments in the females of some Bombycidæ (*Euproctis chrysorrhœa* and *Lymantria dispar*). When the eggs are being deposited, the female covers them with a cotton-like investment of detached hairs, and they are thus very effectively protected against the inclemency of the weather. The form of the investment is specific—irregularly globose or sub-ovoidal in *Lymantria dispar*, elongated and ellipsoidal in *Euproctis chrysorrhœa*, and the shapes of the hairs are also specific. Those of the last-named species are carefully described. They include some remarkable spinose forms, like twigs of briar, with the points of the spines directed towards the apex. The adaptations of the various kinds of hairs, to adhere to the eggs, to separate off from the mother-moth, and to form a sort of web, are explained. It is interesting to find that in the male *Euproctis* the abdominal tuft is slightly different in shape and size, and is formed of quite different kinds of hairs and elongated scales and transitions between the two.

Malpighian Tubes in Lecanium.‡—G. Teodoro describes the structure of the Malpighian tubes in the females of *Lecanium oleæ*, *L.*

* Journ. Quekett Micr. Club, xii. (1915) pp. 441–64 (7 pls.).
† Redia, x. (1915) pp. 1–6 (2 figs.).
‡ Redia, x. (1915) pp. 15–19 (1 fig.).

hesperidum, *Pulvinaria vitis*, and *P. camelicola*, and in the male nymph-stages of the last two. They consist of small cylindrical sacs within which are minute glandular cells, not in intimate contact with one another or with the surrounding tunic, and thus leaving interstices serving for the passage of the excreted products. Teodoro did not find what Veneziani has described in various insects—a basal protoplasm with fine canaliculi or an apparatus with pore-canals.

Abnormalities in Insects.*—Leopoldo Chinaglia calls attention to some abnormalities—a doubling of the right antenna in *Dorcus parallelepipedus*, a greatly reduced (regenerated) left first leg in *Gryllus domesticus*, and an atrophied (regenerated) right third leg in *Arctia caja*.

New Malaria Mosquito.†—C. S. Banks describes *Myzomyia febrifera* sp. n., a mosquito like *M. funesta* Giles and *M. rossii* Giles, which has been bred by Walker and Barber and proved to be a malaria-carrier.

Chironomidæ of Illinois.‡—John R. Malloch has made a detailed study of these midges, with particular reference to those occurring in the Illinois River. In the introduction it is noted that no Chironominæ nor Taypinæ are known to bite, but some Ceratopogoninæ are blood-suckers, e.g. *Culicoides pulicaris* (well-known to be abundant near small lochs in Scotland). Most of the larvæ are aquatic, but some species of Ceratopogoninæ have terrestrial larvæ, sometimes conspicuously spinose, living underneath bark or the like, and even in the nests of Hymenoptera. A very peculiar form, described by Garman, lives on submerged logs. Over a thousand species of Chironomidæ have been described, and this must be but a small fraction of the real whole.

The eggs are enveloped in a gelatinous covering, and form pear-shaped, or rope-like, or compacted masses; most of the larvæ burrow in mud or silt; most species are difficult to detect because of their brownish or greyish colour, but the "blood-worms" are conspicuous. The pupæ seldom leave the burrow or come to the surface till just immediately before the emergence of the adult. A description is given of the general characters of larvæ, pupæ, and adults. The bulk of the memoir is devoted to the systematic description of Chironomids new and old.

Bird Lice of Genus Docophorus found on British Auks.§—James Waterston discusses the structure of the male genitalia, which afford easily recognized and exact specific characters. "So very sharply defined indeed are the chitinized portions of these organs, that it is in many cases possible by this means to determine accurately mere fragments of insects so bleached and rubbed as to be otherwise unrecognisable." The structures in question are complex and have an elaborate terminology. The author deals with five species of *Docophorus* from British auks, and gives a diagnostic key based on characters of the male genitalia alone.

* Redia, x. (1915) pp. 7-13.
† Philippine Journ. Sci., ix. (1914) pp. 405-7.
‡ Bull. Illinois State Lab. Nat. Hist., x. (1915) pp. 275-543 (24 pls.).
§ Proc. Roy. Phys. Soc. Edinburgh, xix. (1915) pp. 171-6 (5 figs.).

Life-histories of Species of Heptagenia.*—W. A. Clemens deals with three new species in this Ephemerid genus and some nymph-stages not previously described. He devotes special attention to the life-histories. The nymphs mostly inhabit swift water, clinging to the sides and under surface of stones. They are adapted to this life by reason of many interesting specializations, chief of which are much-flattened bodies, broad margins to the head, spreading legs with flattened femora, pectinated claws, tracheal gills placed dorsally in an overlapping series, and spreading setæ. A few species, however, are common in quiet water, notably *Heptagenia canadensis*, *H. frontalis*, and *H. tripunctata*—the last being very abundant.

The nymphs are active in habit, and when a stone is lifted from the water they scurry over its surface, usually seeking the lower side. In a vessel without anything to cling to they begin clinging to each other and are soon in a single mass. They feed on algæ on the stones.

The life-cycle of a *Heptagenia* is complete in a year. The egg is deposited in the water and hatches in about forty days. The remainder of the mayfly's life is spent in the water as a nymph, with the exception of a short aerial life of from two to four days as a subimago and imago. As the time of emergence approaches, the nymphs probably migrate to the quieter water. The subimago stage lasts about a day. The imagos never appeared in large swarms, as in *Ephemera* and *Hexagenia*, but a swarm would consist of perhaps fifty to a hundred individuals. They would begin their flight from three-quarters to half an hour before dusk, dancing up and down in their rhythmic manner at a height of from 12 to 20 feet. The females of all the species observed deposited their eggs by skimming the surface of the water and brushing off the eggs as they appeared from the openings of the oviducts.

Mitotic Spindle in Spermatocytes of Earwig.†—C. F. U. Meek has inquired into the factors determining the length of the mitotic spindle in the spermatocytes of *Forficula auricularia*. The length of the spindle at the stage immediately preceding the conclusion of the primary spermatocyte metaphase is not a constant. The length of the spindle at the conclusion of the primary spermatocyte metaphase is not a constant, and is sometimes smaller than that observed at the stage immediately preceding the conclusion. The length of the spindle in the early primary spermatocyte anaphase is not proportional to the amount of chromosome divergence, and is sometimes smaller than the lengths observed at the stages mentioned above. The volumes of the primary spermatocyte cells vary in the metaphase. The length of the spindle at the conclusion of the primary spermatocyte metaphase is not proportional to the volume of the cell. The length of the spindle at the stage immediately preceding the conclusion of the secondary spermatocyte metaphase is not a constant. The length of the spindle at the conclusion of the secondary spermatocyte metaphase is not a constant, and is sometimes smaller than that observed at the stage

* Suppl. 47th Rep. Dept. Fisheries Ottawa, 1915, Fasc. 2, pp. 131–43 (4 pls. and 1 fig.).

† Quart. Journ. Micr. Sci., lxi. (1915) pp. 1–14 (2 pls.).

immediately preceding the conclusion. The length of the spindle in the early secondary spermatocyte anaphase is not proportional to the amount of chromosome divergence, and is sometimes smaller than the lengths observed at the two last-mentioned previous stages. For the case investigated, the length of the spindle at the conclusion of the metaphase is not proportional to the volume of the chromatin or to the volume of the cell.

Male of Indian Stick-insect.*—Annie C. Jackson has some notes on the male of *Carausius morosus*, which seems to be very rare among those bred in captivity. Seven were identified out of three thousand. Redtenbacher has described the male in his monograph on Phasmidæ, without any comment as to its rareness or otherwise. The male differs from the female in its smaller size and more slender appearance, and the antennæ and legs are proportionately longer. The red vermilion character present in the adult female on the inner side of the femur of the front legs is usually absent in the male.

As regards Lice.†—J. Parlane Kinloch communicates some interesting facts in regard to the conditions of louse-life, and the best methods of destroying lice and other "body vermin," which are of increased importance nowadays in view of the established relationship between their occurrence and the spread of disease, such as typhus.

Leuwenhoek, more than 200 years ago, bred lice on his own person, wearing for this purpose a special garter under which the insects were confined. Kinloch has found a finger-stall still more effective. "Even when the experiments were long continued the finger suffered only from a condition somewhat analogous to a mild trench frost-bite as at present described." Warburton bred lice in a glass tube, which was kept close to the person night and day, except during the twice-a-day feeding. But Kinloch has found that in the incubator at body-temperature, and in the presence of a certain amount of moisture, lice can be bred and reared and kept alive for many days. For feeding purposes they were lifted by a claw in a pair of fine flat-pointed forceps. It is not yet clear whether the louse introduces the infection of typhus or relapsing fever in the act of feeding on its host, or whether it is by means of its fæces that infection is conveyed. It was observed that defæcation constantly accompanied feeding.

Lice can be revived after immersion in a weak salt solution for sixty hours, in river-water for forty-eight hours, in distilled for twelve hours. Dry-heat appears to be more destructive than moist-heat of equal temperature. It has been possible to revive lice after immersion for one minute in water at 100° C. Lice exposed to the same temperature for one minute in air never survive. Indeed, so far, neither lice nor their eggs have been found capable of surviving exposure for half an hour to a dry-heat of 65° C.

It has been found impossible to revive lice or to rear their eggs after

* Proc. Zool. Soc., 1915, p. 155.
† British Med. Journ., June 19, 1915, pp. 1-9.

immersion in petrol for one minute. The vapour kills all lice and nits within half an hour. A solution (1 in 4) of petrol in vaseline is very effective in application to the human body. Benzine, toluene, and acetone are at least as lethal as petrol; they are, however, also very inflammable. There is reason to believe that the insecticidal action of the lower paraffins may depend on their greater diffusibility, and possibly on their greater solvent action on some fatty or waxy substance in the cuticle of the louse.

Certain chlorine derivatives of methane, ethane, and ethylene are more lethal to lice than any other substances as yet tried, and they are non-inflammable. A 25 p.c. solution of dichlorethylene or trichlorethylene in vaseline is very effective in application to the human skin. Phenol disinfectants are not efficient unless the steeping tank be kept at 65° C. Volatile oils have no direct insecticidal effect. Impregnating garments with sulphur and the like is of little direct use. The louse can feed through all sorts of ointments. The use of a petrol or benzene bath is the main recommendation for clothes; for the body, soaps containing derivatives of ethane and ethylene, or trichlorethylene in vaseline, or petrol in vaseline.

Clover Pests.*—Giacomo del Guercio discusses a remarkable weakening and masking of *Trifolium pratense* observed in Italy during recent years. The root system is attacked by *Hylastes trifolii*, the stems by *Apion virens*, the flower-heads by *Apion apricans*. Cecidomyid larvæ are also present, and the root system is furthermore attacked by *Tylenchus devastator*, and less abundantly by species of *Heterodera*. Interesting photographs are given showing the hardly recognizable appearance of the infected plants. The infection is very fatal.

γ. Prototracheata.

Distribution of Onychophora.†—Austin H. Clark has made a detailed study of the distribution of the Onychophora. Although we have no palæontological evidence upon which to base the conclusion, it would appear that the Onychophora represent a very ancient type. Like most ancient types (1) they are strictly nocturnal, (2) they are all built upon the same plan with very little divergence from the mean, and (3) they indicate land connexions which we know to have been very ancient.

So far as we know, the Onychophora are confined within a relatively narrow and circumscribed physical range; that is, they require a fairly uniform temperature within very moderate extremes, and a uniformly high humidity. Although existing within very narrow physical limit, they are in certain ways more independent of their immediate surroundings than the great majority of Invertebrates, for they are predacious, and apparently feed upon any organisms small enough for them to overcome.

The most striking feature of the geographical distribution of the

* Redia, x. (1915) pp. 235–301 (2 pls.).
† Smithsonian Misc. Coll., lxv. (1915) pp. 1–25.

Onychophora, as we know it to-day, is the restriction of all the species to the region south of the Tropic of Cancer, and of the great majority of them to the southern hemisphere; only in the West Indies and in Central America do we find an appreciable number north of the equator. Another very striking feature is the geographical distinctness of the systematic units. Nowhere, so far as we know, do species of the Peripatidæ and of the Peripatopsidæ occur together. The two sub-families of the Peripatidæ are separated by the entire breadth of the Indian Ocean.

There is a suggestion of zonal distribution, the Peripatidæ being equatorial (the Malay Peninsula and Sumatra, Central Africa and tropical South and Central America), the Peripatsopsinæ intermediate (New Britain, New Guinea and Ceram, Natal, and the adjacent portions of Cape Colony), and the Peripatoidinæ austral (Australia, Tasmania and New Zealand, Natal and the Cape Colony, and Chile).

δ. Arachnida.

Scottish Spiders.*—A. Randell Jackson makes a second contribution to our knowledge of the spiders of Scotland. In a fortnight's holiday he collected 139 species, of which seven were previously unrecorded for Scotland and two were also new to Britain. He has special notes on *Micryphantes nigripes* Simon (hitherto known from French and Swiss Alps at high altitudes), *Dismodicus elevatus* C. L. K., and *Trochosa biunguiculata* Camb. A description is given of *Clubiona humida* sp. n. from moss in swampy localities in the Delamere forest.

Genus Lebertia.†—W. Williamson and C. D. Soar discuss this genus of Hydracarina, and describe the (eleven) British species. Two sub-genera, *Lebertia* (Sig. Thor's *Neolebertia*) and *Pilolebertia* form a smooth-skinned group; three sub-genera, *Mixolebertia*, *Pseudolebertia* and *Hexalebertia*, form a second group in which the skin is not dotted over with fine pores, or has them indistinctly visible. But a more distinctive feature is the presence of papillæ or of ridges varying in length. Species which are apparently smooth-skinned, but belong to this group, may be distinguished from the preceding group by the presence of *six* long bristles on the third segment of the palpi instead of five. As a rule, swimming hairs are either quite rudimentary or absent.

New Acarina.‡—Antonio Berlese continues to make notable additions to our knowledge of Acarina. He revises the genus *Oribates*, which he divides into two sub-genera, *Oribates s. str.* and *Neoribates* sub-gen. n. To both he has new species to add. Among Mesostigmata he establishes the new genera *Eutrachytes*, *Hoploseius*, *Ologamasellus*, *Coleolælaps*, *Amblyseius*, and *Cercomegistus*. Among Prostigmata, the new sub-genus *Eupodolophus* is established.

* Proc. R. Phys. Soc. Edinburgh, xix. (1915) pp. 177–90 (1 pl.).
† Journ. Quekett Micr. Club, xii. (1915) pp. 479–514 (2 pls.).
‡ Redia, x. (1915) pp. 113–50 (4 pls.).

ε. Crustacea.

Reactions of Isopods.*—W. C. Allee finds that certain conditions known to affect the rate of metabolism of animals regularly affect the rheotactic reaction of *Asellus communis* Say. Low oxygen, chloretone, potassium cyanide, lowered temperature, suddenly heightened temperature, increased carbon dioxide tension, and starvation, all of which depress the rate of metabolism of animals, also lower the positive rheotactic response of Isopods. High oxygen, caffein, and a gradual increase in temperature have the opposite effect. Allee measured the rate of metabolism by means of the survival time in potassium cyanide, and found that high positiveness in the rheotactive reaction is the expression of a relatively high rate of metabolism, and low positiveness of a low metabolic rate.

New Copepod from Hollows on Tree Trunks.†—D. J. Scourfield describes *Moraria arboricola* sp. n. from little reservoirs of water on trees in Epping Forest. It has not been found elsewhere; most, if not all, of the members of the genus live in wet or damp mosses. The genus *Moraria* is very closely allied to the well-known genus *Canthocamptus*, and is sometimes included with it. The animals do not swim well; they have great powers of clinging; they are capable of living for a very long time in quite small quantities of water and with scarcely any food. On one occasion specimens continued in evidence for four and a half years in a small glass tube in which the collection had been brought home.

Annulata.

Effect of Radium on Fertilization in Nereis.‡—Charles Packard finds that radiated spermatozoa of *Nereis limbata* react in two ways to the normal egg. They may normally stimulate it, and be drawn in, but subsequently fail to develop; or they may fail to stimulate the egg sufficiently and so remain outside. In the first case, the sperm nucleus and aster may fail to develop and to fuse with the egg nucleus. In the second case, the egg nucleus develops without an aster.

The radiated egg at the time of fertilization may or may not extrude the cortical layer. In either case, the maturation phenomena are more or less abnormal. The germ nuclei develop abnormally and mitosis does not occur, though the protoplasm may divide.

Radiation of the fertilized egg results either in a failure of the fully developed germ nuclei to fuse, or in abnormal division of the cleavage nucleus. Eggs radiated before and after fertilization show very marked evidences of protoplasmic degeneration. In general, both protoplasm and chromatin are affected. It is suggested that the radium radiations act indirectly on the chromatin and protoplasm by activating autolytic enzymes, which bring about a degeneration of the complex proteids, and probably by affecting other protoplasmic substances in the same manner.

* Journ. Exper. Zool., xvi. (1914) pp. 397–412.
† Journ. Quekett Micr. Club, xii. (1915) pp. 431–40 (2 pls.).
‡ Journ. Exper. Zool., xvi. (1914) pp. 85–128 (3 pls.).

Leech of the Angler.*—W. Harold Leigh-Sharpe gives a careful description of *Calliobdella lophii*, a leech found on the ventral surface of the angler (*Lophius piscatorius*), where it was discovered in 1863 by Hesse. It is markedly divided into a neck and a body. Each body segment consists of six annuli. Along the side of the body are eleven pairs of pulsating respiratory vesicles. The common terminal portion of the ductus ejaculatorii opens into a large and wide bursa which can be protruded, wherewith is formed a copulatory apparatus which is at least as long as the breadth of the body in the same place, and has at its end a peculiar muscular part. There is a pair of vesiculæ seminales. There are no eyes. Blackish-brown star-shaped pigment cells are absent.

These are all characters of the genus *Calliobdella*; the species is marked by the extreme size of the posterior sucker, which is more than twice the maximum breadth of the body and four times the size of the mouth sucker. The body is not bestrewn with yellow dots. Immediately behind the neck the body increases in breadth more rapidly than in *C. nodulifera*, so that the relative difference between the two parts is more marked, and the flattened condition of the abdominal part is thus the more strongly noticeable, a condition which is probably dependent on the weak development of the musculature of that part. The eggs are oval, those of other species are hemispherical. According to Hesse, they adhered to the wall of the vessel in which the leeches were kept by a gelatinous secretion; they much resembled the cocoon of the silkworm, and their surface was covered with very crisp and curly yellow "silk."

The author seeks to distinguish between *Calliobdella* and *Trachelobdella* in which Blanchard described four non-respiratory vesicles on the preclitellum, twelve pairs of respiratory vesicles, and three or six annuli on the abdominal somite. In *Calliobdella* there are no vesicles on the preclitellum, there are eleven pairs of respiratory vesicles, and there are six annuli on the abdominal somite.

It is argued that *Calliobdella lophii* is a perfectly stationary parasite, never quitting its host. In support of this conclusion, reference is made to the extreme size of the posterior sucker, the weak development of the longitudinal muscular layer, the occurrence of four or five specimens on the angler and on it alone, the careful movements of the animal. There is only one cæcum, and its lumen is partly obliterated. The cæcum was empty, and there was very little food in the whole alimentary tract, which suggests that the animal does not need to gorge itself.

Hirudinea of Georgian Bay.†—C. G. S. Ryerson communicates some notes on the Hirudinea of Georgian Bay, Lake Huron. Four families are represented: Glossiphonidæ, with five species of *Glossiphonia* and five of *Placobdella*; Hirudinidæ, with *Macrobdella decora* and two species of *Hæmopis*; Erpobdellidæ, with *Erpodbdella punctata* and *Nephelopsis obscura*; and Ichthyobdellidæ, with two species of *Piscicola*.

* Parasitology, vii. (1914) pp. 204–18 (5 figs.).

† Contrib. Canadian Biol., Suppl. 47th Rep. Dept. Fisheries, Ottawa, 1915, Fasc. ii., pp. 165–75.

Nematohelminthes.

Life-history of Onchocerca.*—W. Nicol discusses the life-history of this parasite, which causes nodular disease in cattle in Australia. The facts point to the Breuil's conclusion that the larvæ penetrate the skin and emerge in water. From excised nodules the larvæ emerged in large numbers for some time after the death of the host. They make their way through the capsule, and infection may be water-borne. On the other hand, when the larvæ are near the surface of the skin, they might be very readily ingested by any biting insect, such as cattle-fly or mosquito—a view that has been repeatedly suggested.

Platyhelminthes.

New Species of Amphilina.†—T. Southwell reports on *Amphilina magna* sp. n., one of the primitive Cestodarian tapeworms. It occurred in the body-cavity of a marine fish, *Diagramma crassispinum*, and was of unusual dimensions, 250 mm. in length by 12 mm. in breadth.

Structure of Amabilia.‡—F. E. Beddard discusses some peculiarities in the structure of *Amabilia lamelligera*. The head was so completely retracted that there was no external sign of its existence save a slit-like gap anteriorly. It is hardly more than an eighth of a millimetre in breadth, and cannot be an effective anchor for the unwieldy body. The longitudinal muscular layer of the body is continued into the lateral outgrowths of the proglottids, which are characteristic of the family Amabiliidæ. A transverse section of these appendages shows strands of muscle passing from side to side, and considerable movement must be possible. It may be that the worm is able to fix itself to the wall of the intestine more securely by means of these appendages, as well as to move from place to place, and their existence, as functional parapodia, may supplement the feeble scolex.

The water-vascular or excretory system consists of a median stem opening by a pore both dorsally and ventrally, of two transverse vessels on each side connecting this with two lateral longitudinal vessels, one lying above the other; these communicate at the orifice of the transverse vessels: there is no network of small tubes. Beddard calls attention to the likeness shown by the vertical, radiating and lateral tubes to the canal-system of a Ctenophore.

The testes are in one or two horizontal rows, four to six deep, disposed in two groups separated by ovary, rarely forming a continuous row. The cirrus-sacs are large and muscular, two in each proglottis. The opening is on each side between the lateral water-vessels and dorsal to the nerve-cord. The cirrus is armed with numerous spinules. The vas deferens is short, without a coil, opening into an oval vesicula seminalis connected by a short duct with the cirrus-sac. The ovary is

* Rep. British Assoc., Australia, 1915, pp. 407–9.
† Bull. Dept. Fisheries Bengal, No. 5 (1915) p. 32.
‡ Proc. Zool. Soc., 1915, pp. 175–91 (8 figs.).

single, consisting of fine filamentous threads radiating out from the base where the oviduct arises. The vagina opens into an anteriorly placed diverticulum of the vertical water-vascular tube. The uterus consists of a dorsal and a ventral network connected by vertical tubes. The ripe eggs, according to Lühe, are long and spindle-shaped. Beddard also calls attention to the occurrence of a definite lateral uterine pore on some joints of *Dasyurotænia robusta*.

Life-history of Proteocephalus ambloplitis.*—A. R. Cooper gives an account of his observations on the life-history of this Cestode parasite of the Black Bass. A few Plerocercoids occur in the stomach, many in the intestine, liver and gonads. The structure of the Plerocercoids is described. The evidence points to *P. ambloplitis* having at least two intermediate hosts—the first, some unknown species of aquatic Arthropod ; and the second, either minnow, perch, or the final host itself. A description is given of the egg and oncosphere.

New Liver-fluke from a Kestrel.†—W. Nicoll describes *Platynosomum acuminatum* sp. n. from the liver of a kestrel (*Cerchneis tinnunculus*) shot on the west coast of Scotland. It bears a close resemblance to *P. deflectens* and *P. petiolatum*, but is distinct.

Incertæ Sedis.

New Pentastomids.‡—Mary L. Hett describes *Porocephalus grandis* sp. n. from African vipers (*Bitis gabonica*, *B. nasicornis*, and *Cerastes cornutus*). In the female the anterior third of the ovary is paired and the organ forms a Y-shaped structure, each arm of the Y passing into the oviduct of that side. The species resembles *P. armillatus* Wyman, but the body is relatively thicker, the papillæ are differently arranged, the hooks are sunk in a pit and not so wide apart, the space between the two inner hooks is relatively greater, the rings (twenty-two distinct in the female and two or three indistinct, instead of nineteen altogether) are not so sharply defined, the postero-ventral margin of each ring has a slight projection in the median line instead of an indentation, and the anal segment is more obtuse. Another new species, *P. globicephalus*, from the lung of the Moccasin Snake (*Tropidonotus fasciatus*), greatly resembles the Indian species *P. pattoni*, but has more rings and a more nearly terminal anus. Three other species, with two new varieties, are described.

Rotatoria.

Transmission of Induced Characters in Asplanchna amphora.§ Claude W. Mitchell and J. H. Powers find that variation in this species is, in last resort, entirely under the control of nutrition ; that in character it is deep-seated, pervasive, erratic and sudden—bearing all the ear-

* Contrib. Canadian Biol., 47th Rep. Dept. Fisheries, Ottawa, 1915, Fasc. ii., p. 177–94 (3 pls.).
† Proc. Zool. Soc., 1915, pp. 87–9 (1 fig.).
‡ Proc. Zool. Soc., 1915, pp. 115–21 (4 figs.).
§ Journ. Exper. Zool., xvi. (1914) pp. 347–96.

marks of mutation; and that it is hereditary in a strong though variable degree throughout the parthenogenetic series.

In several respects variation in this Rotifer appears like a species-making process. The different types produced occur erratically, though sometimes abundantly, in nature; their differences would be quite sufficient for specific distinction, and several of the forms produced closely parallel types of the genus which have been assumed to be definite species. But unless the variation affects the sexual gametes, it is not akin to species-making, and at first sight it seems that all the fertilized or resting eggs hatch as individuals of the small saccate type, which represents in general the primitive phylogenetic form of the entire genus. The astonishing variations of the parthenogenetic series, germinal though they are, thus seem to be wiped out by sexual reproduction, much as the somatic modifications of the complex Metazoan are wiped out by the same process.

What the authors have sought to discover is whether the wiping-out process is complete; whether the fertilized egg is so different a thing from the parthenogenetic egg; whether the entire variation of the species, and doubtless of the genus as a whole, is but the play of the environment upon parthenogenesis as such, or whether it is the result of the forces fundamentally modifying the gametic constitution of the species. The first generation of young from the fertilized egg is always *structurally* the same from whatever type of the species the egg is derived, but it is possible that the young saccate individuals derived from different eggs differ *physiologically* and in their reproductive tendencies. The inheritance through the fertilized egg need not manifest itself in the visible characters of the individual which emerges from this egg; it may be hidden as tendencies only to manifest itself in later generations.

The general conclusion reached is that germinal changes (induced by peculiarities in nutrition) may be transmitted through sexual as well as through parthenogenetic generations. It is a remarkable fact that a certain type or form when once induced (the humped form of *A. amphora*) may in reality be transmitted with full force despite an interruption of one or more generations in which this form is not expressed. Although the conditions are totally different, the phenomenon suggests that of recessive and dominant characters. The authors have also found that the union of gametes has little, if any, influence on the vitality or variability of the *Asplanchna* stock.

Echinoderma.

Larva of Porania pulvillus.*—James F. Gemmill describes a feeding brachiolarian stage in the life-history of this Phanerozonate Asteroid, which shows that the division into Phanerozonia and Cryptozonia is not necessarily associated with fundamental differences in development. The blastula formation is by egression of central cells in lines appearing externally as surface furrows. There is a practically

* Quart. Journ. Micr. Sci., lxi. (1915) pp. 27–50 (2 pls.).

constant presence of what seems to be a rudimentary posterior entero-cœlic outgrowth, of importance in connexion with the question of the origin of the cœloms. The main enterocœles arise often, if not always, by a single outgrowth. There is very frequently a double hydropore in the early larvæ. The special characters of the brachiolaria are defined. The late larva is provided with a system of neuro-muscular and neuro-epithelial fibres. Larvæ with double hydrocœle are described and their morphological import is discussed.

Asteroid Larvæ.*—James F. Gemmill describes a new brachiate Asteroid larva, which he names *Brachiolaria hibernica* sp. n. The brachia are stout and columnar, with very slightly convex ends, each of which carries about twenty papillæ. The sucker is much elongated transversely; a single row of six or seven papillæ is present on each side of the sucker; there are no papillæ on the sides of the brachia; the ciliated processes are cylindrical at their extremities. It was taken in a net drawn up from 1150 fathoms to the surface, 50 miles N. by W. of Eagle Island, West of Ireland. A figure is given for the first time of the advanced bipinnaria of *Luidia ciliaris*, and details are supplied as to the number and arrangement of the ciliated appendages, and the dorsal and ventral median lobes.

Double Hydrocœle of Starfish Larva.†—J. F. Gemmill discusses the occurrence of a right as well as a left hydrocœle in the larva of *Asterias rubens*. The presence of two stone-canals, pharyngeal cœloms, and axial organ rudiments, and their relation to one another and to the mesial dorsal sac, afford confirmation of the view that the homology between *Balanoglossus* and Echinoderms extends to many details of structure. According to this view, the dorsal sac is the equivalent of the pericardium in *Balanoglossus*, while the axial organ and pharyngeal cœlom are equivalent respectively to the left pharyngeal efferent vessel and the left pharyngeal cœlom of *Balanoglossus*.

Cultures obtained from artificial fertilizations, and reared by feeding with *Nitschia*, showed far greater numbers of larvæ with double hydrocœles than occur in nature. Hurried maturation of nucleus and cytoplasm of the ova, and unnatural nutrition of the larvæ, may induce developmental instability, and the tendency to double hydrocœle may be atavistic. Perhaps, also, there is a "primary" homœotic tendency to bilateral symmetry. There is also a somewhat different homœosis, which may be described as "secondary" or "casual," manifesting itself later in development, getting the opportunity to do so through failure of a particular difference between the right and left sides to become established at the proper time, development thereafter proceeding on the same lines on both sides. The initial failure may be due to environmental causes, which in the case of double hydrocœle seem to be connected with nutrition. At a certain stage the right middle cœlom may be left isolated posteriorly like the left middle cœlom, from a cause proximately connected with nutrition, and thereafter, through secondary

* Proc. Roy. Phys. Soc. Edinburgh, xix. (1915) pp. 191–99 (1 pl.).
† Quart. Journ. Micr. Sci., lxi. (1915) pp. 51–80 (2 pls.).

homœosis, follow the same course of development as the left middle commissure. The great majority of double hydrocœles may be accounted for in this way, but the possibility must not be excluded that, given initial instability, the influence of atavism and primary homœosis may sometimes be sufficiently strong to induce the formation of double hydrocœle apart from the action of environmental factors.

The data from double hydrocœle accord with the view that there has been a fixed stage in the evolution of Echinoderms; that fixation took place in the middle line of the preoral lobe; and that, as in *Antedon*, freedom was obtained by loss of the attaching stalk.

Twin Gastrulæ and Bipinnariæ of Luidia sarsi.*—J. F. Gemmill describes various types of twin *Luidia* larvæ, which may be classified according to the same system as Double Monstrosities among Vertebrates, the alimentary canal of the larvæ being taken as their representative axial structure. The causation depends on early partial separation of cells or of cell masses, accompanied by a minimal interference with the vitality of the whole. Doubling (partial or complete) of the gastrula invagination is the great step on which the differentiation of twin bipinnariæ depends. This differentiation shows very markedly the working of "regulation" processes, in the course of which, when union of structures occurs, the union is always between structures of homologous origin. Thus preoral and postoral bands, enterocœles, and particular regions of the alimentary canal unite each with its counterpart.

Axial Gradients in Early Development of Starfish.†—C. M. Child has found evidence of an axial gradient of susceptibility (to cyanide) in the cytoplasm and nucleus of the egg of *Asterias forbesii*. The existence of a quantitative metabolic gradient is confirmed by observations on the rate of the oxidative formation of indophenol in the egg. The gradient coincides in direction with the axis determined by the excentric position of the nucleus in the ovarian egg. The region of highest metabolic rate in this axial gradient becomes the animal pole of the egg and the apical region of the larva.

The gradient probably persists through the cleavage stages, and is very distinct in the blastula and gastrula. It finally disappears in the bipinnaria larva as metamorphosis approaches. Somewhat less complete evidence points to the existence of symmetry gradients, in which the region of highest rate becomes the oral side of the larval body, the region of lowest rate the aboral side. These metabolic gradients are directly related only to the larval axes. Towards metamorphosis they disappear, and later the new axial gradients of the starfish body arise.

Experimental Study of Cleavage in Sea-urchin Ova.‡—Theophilus S. Painter has experimented with the ova of *Strongylocentrotus*, which he subjected to violent shaking for a few (4–7) minutes after fertilization, with the result that in a varying proportion of cases the centrosome

* Journ. Marine Biol. Assoc., x. (1915) pp. 577–88 (3 pls.).
† Amer. Journ. Physiol., xxxvii. (1915) pp. 203–19 (10 figs.).
‡ Journ. Exper. Zool., xviii. (1915) pp. 299–317 (3 pls.).

fails to divide and only one division centre is obtained. The author proceeded to study the cleavage of these monaster eggs, and was led to the general conclusion that at the time of fertilization progressive changes, which go on independently of the nucleus and of cleavage, are initiated in the cytoplasm of the eggs, and that these changes determine the position of the spindles in the egg and consequently in the blastomeres.

The monaster eggs were isolated and followed through their cleavage. At the time when the control eggs were in the sixteen-cell stage, one or more small cells appeared in the cleaving monaster eggs. These were usually in the eight-cell stage at this time. In order to determine the cause of micromere formation, eggs were treated with potassium cyanide and phenyl urethane, or were kept at a low temperature after fertilization. By treating the eggs with phenyl urethane it was possible to throw the micromere formation into the two-, four- or eight-cell stage. The evidence goes to show that differentiation, in so far as the formation of the micromere is concerned in the sea-urchin egg, is dependent upon cytoplasmic oxidation, the nucleus and the cleavage process playing no direct part here.

Cœlentera.

Comparative Anatomy of Some British Actiniæ.*—Oliven M. Rees describes *Sagartia miniata*, *S. ornata*, *S. sphyrodeta*, *Anthopleura alfordi*, *Corynactis viridis*, and the rare *Aurelianìa regalis*, giving details as to the transverse sections of body-wall, mesenteries and tentacles.

Porifera.

Gemmules of Ficulina and other Sponges.†—Karl Müller has made a study of gemmules in *Ficulina ficus* and some other sponges. A list is given of those sponges in which the occurrence of true gemmules has been proved, and of those in which gemmule-like bodies occur. In *Ficulina* they usually occur in a dense layer next the substratum or the shell on which the sponge grows. In some cases they occur freely in the body in crowded roundish clumps; they are never isolated from one another as in Spongillidæ. It is often easy to separate off the sponge from the substratum, leaving the gemmule layer attached. The gemmules vary greatly in size and shape. Each consists of a cellular body and a capsule of two concentric spongin layers without a pore. The capsule is strengthened by spinose microrhabda or amphidiscs. The internal cells are polygonal, compressed and laden with yolk-material. A gemmule arises from a collection of archæocytes, into which more elements migrate. There is a gradual differentiation into internal yolk-cells and a double layer of follicle-like epithelial cells round the circumference. The latter secrete the membrane. The microscleres, microrhabda and amphidiscs, are not formed from the epithelial cells but in normal scleroblasts outside the gemmule. They are transported to the

* Journ. Marine Biol. Assoc., x. (1915) pp. 521–61 (16 figs.).
† Wiss. Meeresuntersuch. Kiel, xvi. (1914) pp. 289–313 (4 pls. and 10 figs.).

wall of the gemmule by amœboid "phorocytes." The aggregates of gemmules in the body of the sponge sometimes have some foreign concretion in their interior, and sometimes have no nucleus at all.

Pectispongilla.*—Nelson Annandale redefines this genus of fresh-water sponges. It includes small Spongillinæ of massive or encrusting habit, of soft and friable consistency, with delicate skeletons in which vertical fibres, though well-defined and not devoid of horny substance, are always very slender. Dermal membrane aspiculous; skeleton-spicules rough or smooth amphioxi; free microscleres present in the flesh of the sponge, often of more than one type; gemmule-spicules with the extremities flattened and expanded in the main axis, the terminal expansions bearing, on one face only, large spines arranged longitudinally in parallel comb-like rows. The type species is *Pectispongilla aurea* Annandale. Two others are described. The geographical distribution is in the plains of Travancore and Cochin, in the southern part of the Malabar zone of Peninsular India—a limited range. The genus is probably derivable from a little group of species of *Spongilla*, in the sub-genus *Euspongilla*, typified by *S. crateriformis* Potts.

Protozoa.

Reproduction of Hypotrichous Infusorians.†—G. A. Baitsell has studied the so-called life-cycle in *Oxytricha fallax* and *Pleurotricha lanceolata*, which were cultivated in a "constant" medium consisting of a 0·025 p.c. solution of Liebig's extract of meat, a hay-infusion medium, and a "varied environment" medium. The cultures were kept under observation for many months, in one case for nearly two years. At the beginning in each case the animals gave evidence of being thoroughly normal, but previous to the dying out of a culture there was an appearance of atypical and degenerate individuals, similar to those found by former investigators, and interpreted by them as due to an inherent condition of senescence. The experiments indicate, however, that the dying out of some of the culture was due, not to a condition of inherent senescence, but to the fact that the culture conditions supplied were not entirely favourable to the indefinite existence of the organisms bred under observation. In *Oxytricha fallax* "sister cells" bred in a mass-test-tube culture lived more than twice as long as those bred in daily isolation cultures. In the case of *Pleurotricha*, culture conditions have been found (in a hay-infusion medium) in which this organism will apparently live indefinitely without conjugation or artificial stimulation.

Architecture of Foraminifer Shells.‡—E. Heron-Allen directs attention to the purposiveness and beauty of some of the shells made by Foraminifera. Some forms, such as *Haplophragmium agglutinans*, incorporate into their shells fragments of heavy gem minerals, such

* Records Indian Mus., xi. (1915) pp. 171–8 (5 figs.).
† Journ. Exper. Zool., xvi. (1914) pp. 210–34 (1 pl.).
‡ Ex. Reports Royal Institution, May 21, 1915, pp. 1–13.

as magnetite, garnet, and topaz, which by reason of their specific gravity are not to be found in the same sand-strata as the relatively light quartz-grains which are mainly used in the construction of the shell. Some species of *Psammosphæra*, e.g. *P. fusca*, build agglutinated shells of sand-grains collected without selection; *P. testacea* uses only the shells of dead and living Foraminifera, and it has nothing else to use: *P. parva*, finding itself by its small size and free habit liable to suffocation in the ooze in which it lives, builds a tent-pole arrangement of sponge spicules—several individuals frequently combining to form a mutually supporting mass. This creature fills in the triangular spaces between the main tent-poles with broken spicules of successively graduated lengths, and when it arrives at an awkward terminal space finds and incorporates a truncated triaxial sponge-spicule to fill in the angle.

Many of the larger Foraminifera are liable to attack from parasitic worms; thus the softly-agglutinated shells of *Crithionina pisum* are often bored. But certain individuals of this species protect themselves with a chevaux-de-frise of sponge-spicules, and escape from being bored. In *Marsipella cylindrica* the investment of sponge-spicules is very friable, the spicules being set parallel to the axis; in *M. spiralis* the spicules are twisted into a left-handed spiral, which increases resistance to shock. In *Technitella legumen* there is an outer layer of sponge-spicules parallel to the axis, and an inner layer at right angles to this. In *T. thompsoni* "purposive selection" reaches a climax, for out of the vast and heterogeneous mass of material at its disposal the animal selects only the plates of an Echinoderm, which it binds together at their edges with an invisible cement.

Bionomics and Reproductive Processes in Foraminifera.* — Edward Heron-Allen contributes an important paper which deals especially with the processes of reproduction and of shell-making. In regard to the former, the following conclusions are reached. 1. In certain species of Foraminifera (the number of which will doubtless be increased as investigation continues) reproduction takes place not only by the zoospore method observed by Lister and others, but by viviparity and by the budding-off of young individuals. 2. Viviparous young are formed inside the parent shell, and these young emerge from the parent by the dissolution of the base of the shell. 3. The whole of the protoplasm and internal septa of the parent are used up in this process, whereas in zoospore production the protoplasm only is discharged, the shells of the young being secreted outside the parent, from material derived from the surrounding medium, and not from the internal septa. 4. At certain stages of the life-cycle (as in *Arcella*) a young individual is budded off from the aperture of the parent and set free at maturity. 5. Under certain circumstances (possibly fortuitous) the protoplasm extruded from two or more shells mingles, as Schaudinn observed, preparatory to the formation of embryonic shells outside the parent, as described by Lister. 6. The phenomenon hitherto described as "plastogamy" is in the Foraminifera attributable generally to one or other of these last two processes.

* Phil. Trans., Series B, ccvi. (1915) pp. 227–79 (6 pls.).

The author discusses the dual nature of the terminal chamber and other peculiarities in *Cymbalopora bulloides*, and the excavating capabilities of *C. tabellæformis*, which appears to form crypts in fragments of Molluscan shell. He goes on to submit evidence of the purposiveness and "intelligence" of some of the Foraminifera which select for shell-making specific kinds of material and use it in an extraordinarily effective way.

Studies on Parasitic Protozoa.* — Doris L. Mackinnon gives a more complete diagnosis of the Flagellate genus *Embadomonas*, from the intestine of the larvæ of the crane-fly and Trichoptera. The genus contains small slipper-shaped Flagellates, characterized by a very large cytostome bordered by prominent lips, which are more or less siderophilous, and two flagella, not so long as the body, one acting as an organ of locomotion, and the other lying in the cytostome. The spherical nucleus is placed at the anterior end of the cell; the two basal granules, from which rise the flagella, lie at the anterior border of the cytostome. There is a definite periplast, which prevents deformation of the cell. The anterior part of the cell shows a well-marked torsion. The cysts are relatively small and are ovoid in form. As "species characters" may be used: (1) the form of the animal, (2) the nature of the periplast, (3) the degree of development of the cytostome and its lips, and (4) the size of the cysts. Two species are described. The genus *Embadomonas* is certainly allied to *Chilomastix* Alexeieff and to *Fanapepea* Prowazek. The author also describes multiplication cysts of a Trichomastigine in *Tipula*.

Klossiella muris.† — A. C. Stevenson discusses this parasite from the kidney and renal arterioles of the mouse. A stage showing schizogony into merozoites is described. Another type of schizogony of more frequent occurrence shows fifty to sixty daughter individuals. The merozoites seem to enter the cells of the convoluted portion of the kidney as gametocytes or gametes. Fusion or association of two gametocytes takes place, and after this repeated nuclear division. Twelve to sixteen sporoblasts are formed. A cyst-wall forms round the sporoblast and the nucleus divides to form sporozoites. The capsule bursts and the spores travel to the bladder or into the urine.

* Quart. Journ. Micr. Sci., lxi. (1915) pp. 105–18 (1 pl.).
† Quart. Journ. Micr. Sci., lxi. (1915) pp. 127–35 (1 pl.).

BOTANY.

GENERAL,

Including the Anatomy and Physiology of Seed Plants.

Structure and Development.

Vegetative and Reproductive.

Pollen-formation.*—M. Guignard contributes a note dealing with methods of pollen-formation and their significance. It is shown that there are many exceptions to the general rule that successive bipartition is characteristic of Monocotyledons and simultaneous quadripartition of Dicotyledons. In addition to the exceptions found in *Asphodelus*, *Hemerocallis*, and in several species of *Ceratophyllum*, *Rafflesia*, *Asclepias*, and *Apocynum*, the author states that in all the Orchidaceæ which he has examined *Cypripedium* is the only one which exhibits successive bipartition. Many members of one tribe of the Liliaceæ, i.e. the Aloineæ, form their pollen in the same way as Dicotyledons; the same method is found in several species of *Iris*, *Sisyrinchium*, *Ixia*, etc. Recently Samuelsson has shown that in *Aristolochia Clematitis* and *Anona cherimola* the pollen-development is abnormal. In the former species wall-formation is successive and normal, but the thickening of the first wall is unusually rapid. In the second species there is a tendency to wall-formation immediately after the first division of the nucleus; subsequent division is normal. The last case agrees with *Magnolia* and *Liriodendron*, which may be regarded as intermediate between the Monocotyledons and Dicotyledons; the formation of the incomplete wall favours a nearer relation with the Monocotyledons. The author agrees with Samuelsson in the opinion that the occurrence of the same type of pollen-formation in the Magnoliaceæ and Anonaceæ, on the one hand, and in the Aristolochias and Monocotyledons, on the other, offers important phylogenetic considerations.

CRYPTOGAMS.

Pteridophyta.

(By A. Gepp, M.A., F.L.S.)

Branching and Branch-shedding of Bothrodendron.†—Marjorie Lindsey publishes some new evidence about the ulodendroid scars of *Bothrodendron*. Two new specimens of *B. minutifolium* are described, one showing ramification of a type hitherto undescribed. It consists of the end of a main axis, with opposite rows of alternate branches with trumpet-shaped bases. The cortex of the main stem is continuous

* Comptes Rendus, clx. (1915) pp. 428-33.
† Ann. Bot., xxix. (1915) pp. 223-30 (1 pl. and 3 figs.).

with that of the branches, showing the branches to be attached in quite a normal way. These branches themselves show the ordinary bushy, spreading mass of small branchlets usual in known examples of *Bothrodendron*. It is equally clear that the other specimen is a similar though larger branch which has fallen away, its clear-cut, trumpet-shaped ending suggesting that it has broken away along a definite abscission layer. Though previously described examples of *Bothrodendron* in the ulodendroid condition have been attributed to *B. punctatum*, the fact that the two new specimens are *B. minutifolium* is not an unsurmountable difficulty, since these two species, if not identical, are at any rate very closely allied, and it is therefore quite probable that both had the same method of shedding.

Vascular Development in Osmundaceæ and Gleicheniaceæ.*—M. Jossa describes the development of the conducting tissue in the rhizomes of the Osmundaceæ and Gleicheniaceæ. Her conclusions are that, putting aside homologies and the interpretation of organs already developed, and studying instead the development from the growing-point, one finds that :—1. The so-called "mesarch" bundles of the Osmundaceæ begin always in the form of divergents. They are closed divergents, the protoxylem being able besides to disappear secondarily (in Gleicheniaceæ) or to be absent from a part of the bundle, particularly in the stipes, as a consequence of diminished growth. 2. The Osmundaceæ possess a true central and single cylinder (stele, not dictyostele), in the interior of which there is an early development of endarch ligneous vessels, flanked later by centripetal ligneous wings. 3. The leaf-trace, detaching itself from the central cylinder towards the leaf, may become divided, but remains in perfect continuity with the cauline trace, without modification of its orientation or direction. 4. The complex portions, which may form themselves into the central cylinder of the Osmundaceæ, are the homologue of the portions of the ligneous ring of the central cylinder, equally unique of the Gleicheniaceæ. 5. Finally, the protostele of our species (the analogue, but not the homologue of the protosteles of the rhizomes in certain higher plants), where the xylem finally occupies the whole centre, has its origin in a ring which results from the concrescence of isolated cauline bundles, or perhaps of leaf-traces with centrifugal metaxylem.

Anatomy of Cone of Equisetum.†—Isabel M. P. Browne publishes a second contribution to our knowledge of the anatomy of the cone and fertile stem of *Equisetum*. The summary of her results states that :—1. The xylem of the axis of the cone of *E. maximum* is more reduced than that of *E. arvense* and *E. palustre*, but less so than that of *E. limosum*. 2. The cones, with wider steles, have, on the whole, a more reduced vascular system, as though the reduction in width of stele had not kept pace with the reduction in number of elements lignified. 3. The reduction of xylem is manifested by the persistence of

* Univ. Genève. Inst. Bot. Prof. Chodat, sér. 8, fasc. xii. (1914) 42 pp. See also Bot. Centralbl., cxxviii. (1915) pp. 359–61.

† Ann. Bot., xxix. (1915) pp. 231–64 (3 pls. and 5 figs.).

parenchymatous meshes upwards, and by their extension, phylogenetically speaking, laterally and downwards. This leads to great irregularities, especially in the larger cones, these irregularities taking the form of local duplication of the whorls, and even the development of pseudo-whorls. 4. Owing to the persistence of meshes on either side of a strand through more than two internodes, a superposition of traces at their origin is relatively common, especially in cones with a relatively more reduced vascular system. 5. Another effect of the reduction of the vascular system is the presence of unlignified parenchymatous cells between the tracheides, and the poor lignification of the latter, especially in the lower part of the cone. 6. One character, apparently relatively new in the phylogeny, leading locally to increase of xylem, is the tendency for two or more strands to become united by the production of additional tracheides at a considerable distance below the departure of the traces. 7. Groups of medullary tracheides seem to be not uncommon in the cones of *E. maximum*. 8. The traces of the lower whorls of sporangiophores often diverge downwards; this is especially common in the mature cones, and is probably chiefly due to the pull exerted by reflexed sporangiophores, and to the unequal elongation of the inner and peripheral tissues of the axis. Though the analogy with *Palæostachya* is suggestive, the sporangiophores appear to be morphologically distinct in the two genera. The analogy in the course of the traces of the sporangiophores of *Equisetum maximum* and *Palæostachya* is not a close one, and their downward sweep is probably not due mainly to the same causes. 9. An abnormal branching of the cone is described, as are also exceptional cases of the dying out of incoming traces in the cortex. An abnormal abortive branching of the vegetative part of the fertile stem was also met with.

Anatomy of South American Ferns.*—E. Borkowski publishes the results of his anatomical and biological researches on some ferns of the Columbian Andes. The ferns which he studied he divides into three groups:—1. Xerophytes growing at high altitudes, sun-baked and dry, viz. *Polypodium murorum*, *P. angustifolium*, *P. crassifolium*, *Gymnogramme antioquiana*, *G. Mayoris*, *Elaphoglossum lingua*, *Lycopodium Mayoris*. 2. Hygrophytes growing in shaded moist warm places, viz. *Alsophila coriacea*, *Pteris pungens*, *Asplenium præmorsum*, *Diplazium angelopolitanum*. 3. Intermediates, viz. *Doryopteris Mayoris*, *Diplazium Mayoris*, *Polypodium Mayoris*, *Gymnogramme fumarioides*.

Pteridophyta of Formosa.†—B. Hayata publishes an enumeration of the pteridophyta of Formosa, based on the Government collections of the Botanical Survey of the island. He describes and figures seventy-three new species of ferns, three fern-allies, and several new varieties and forms; he also re-describes a number of species which previously were insufficiently defined. His figures give a photograph of the type, with pen-drawings of details—venation, sori, sections, scales, etc.

* Bull. Soc. Neuchât. Sci. Nat., xl. (1914) pp. 3–79. See also Bot. Centralbl., cxxviii. (1915) p. 359.

† Icones Plantarum Formosanarum. IV. Taihoku: published by Government of Formosa, 1914, pp. 129–257 (figs. 68–180).

Bryophyta.

(By A. Gepp.)

Targionia hypophylla.*—Lillian O'Keeffe gives an account of the structure and development of *Targionia hypophylla*. She summarizes her results as follows. 1. The thallus of *T. hypophylla* grows by means of a single apical cell, from which segments are cut off dorsally, ventrally, and on either side. The air-chambers arise by splitting between the epidermal cells, the split extending from the surface inwards through the entire depth of the epidermis; this process is followed by partial closure of the crack due to turgor of the bounding cells; the young chamber next undergoes extension, owing to general growth of the thallus tissue, but remains closed for a considerable time, until the divisions occur which cut out the concentric cell-rings around the pore, when the latter opens and continues gradually to increase in area until the general growth of the thallus ceases. The membrane-like rim around the pore of the chamber is formed from the innermost ring of surrounding cells, the cavity of these cells being almost obliterated by thickening of the walls. 2. The antheridial receptacle may be developed on special short disk-like branches of limited growth, or on ordinary thallus branches, every intermediate condition being found between the two extremes. The centrifugal arrangement of the antheridia, and the scattered distribution of the ventral scales on the disk-like receptacle, indicate that the latter represents a condensed branch system, in which dichotomy occurs rapidly, and the several growing-points formed are of short-lived activity. 3. The bivalved involucre develops simultaneously with the archegonial group, and represents the peripheral region of the archegonial surface, but its further growth, the formation of interlocking processes on its margin, and its closure until the extrusion of the capsule, are dependent on the occurrence of fertilization in one or more of the archegonia. 4. The young sporogonium does not show the octant stage usually regarded as characteristic of Marchantiales, but approaches the "Jungermannia type," a row of cells being formed by successive transverse divisions before the first longitudinal divisions occur. The spore-mother-cells and the elaters occur in approximately equal numbers, and are irregularly mingled, but there is invariably a layer of elater-forming cells immediately within the single-layered capsule-wall, and these cells may either remain attached by their entire length to the inside of the capsule-wall, or by one end only: in the former case making the wall two-layered in places, in the latter case forming fixed elaters.

Polytrichaceæ.†—I. Hagen continues his Notes on the Norwegian moss-flora. In Part XIX. he treats of the Polytrichaceæ, their distribution, their history, as well as questions of nomenclature, system, and morphology. Among the morphological points of the family, the author

* New Phytologist, xiv. (1915) pp. 105–16 (figs.).

† K. Norske Vidensk. Selsk. Skr., 1913 (Trondhjem, 1914) No. 1, pp. 1–77. See also Bot. Centralbl., cxxviii. (1915) pp. 194–5.

describes an annulus which he considers to be the peripheral portion of the upper side of the spore-sac. It is below the epiphragm, at about the level of the sporogonium-mouth. Between the epiphragm and this annulus there is formed a hollow, through the resorption of the cell-tissue. The author surmises that this hollow space contains air, which plays a part in the throwing off of the lid. The annulus does not occur in *Polytrichum alpinum*, since in this species the epiphragm rests on the sporogonium-mouth. The author describes also in detail the manner in which the epiphragm is connected with the peristome-teeth. He finds that *P. alpinum*, *P. gracile*, and *P. sexangulare*, differ from the other species of the family in having the epiphragm toothed at the margin, and situated below the tips of the peristome-teeth. *Catharinæa undulata* is, according to the author's experience, always dioicous, and the male plants are very rare. The plentiful fertility of the species is difficult to explain. *C. Haussknechtii* is distinguished from *C. undulata* both by its synoicous inflorescence and by the epidermis cells of the sporogonium. In *C. Haussknechtii* they are 2–4 times longer than broad; in *C. undulata* they are hardly so long as, or very slightly longer than, broad. In treating of the genus *Polytrichum*, the author writes of the limiting of the mid-rib, which he considers is formed by the one-layered border of the lamina. This is shown particularly on the under side of the leaves of *P. juniperinum*, *P. strictum*, *P. piliferum*, and *P. hyperboreum*, in which one finds inside the one-layered border a zone of quite different epidermis cells. These four species, on the strength of this and other characters (entire leaves with recurved margin, and rounded or conical marginal cells of the leaf lamellæ), form a special group of the genus. The sporogonium annulus is very poorly developed in *Polytrichum*, though it is present in all the species. The principal part of this paper is written in Norwegian, but portions of more general interest are in French.

Drepanocladus.*—J. Ambroz publishes the results of a study of the Bohemian species of the very difficult and variable genus *Drepanocladus*, founded on the abundant material collected by Velenovsky and himself. After giving a detailed historical survey, he furnishes a key for the determination of the thirteen species, and sub-species, etc., found in the district. These he arranges in five groups, some of which are new.

Vegetative Reproduction of Sphagnum.†—E. Melin publishes the first of a series of studies on the biology of *Sphagnum*. In it he discusses the vegetative reproduction, which hitherto has only been observed in specimens under culture. The author here describes the process in *S. compactum*, *S. tenellum*, and *S. Lindbergii*, observed under natural conditions. Innovation-shoots were plentifully developed from both the apical and lateral short branches, and bore no protonemal filaments at their base.

* SB. kgl. böhm. Ges. Prag. Math.-Nat. Kl., v. (1914) pp. 1–66 (figs.). See also Bot. Centralbl., cxxviii. (1915) pp. 379.
† Svensk. Bot. Tidskr., viii. (1914) pp. 191–200 (figs. in text). See also Bot. Centralbl., cxxviii. (1915) p. 166.

Sphagnum in Sweden.* — E. Melin publishes the result of his sphagnological studies in Tiveden, in South Sweden. He divides his matter into four sections. 1. Survey of the most important *Sphagnum*-associations in Tiveden. 2. H. Paul's division of the Sphagna. 3. The question of whether the hyaline cells act as an apparatus for capturing food-stuffs. This he illustrates with a number of figures of sections of stem and leaf. 4. The *Sphagnum*-flora of Tiveden—thirty-four species. He also provides a map to show the distribution of the following species in Sweden, Norway, and Denmark :—*S. Lindbergii*, *S. Wulfianum*, *S. Gravetii*, *S. pulchrum*.

Thallophyta.

Algæ.

(By Mrs. E. S. Gepp.)

Plankton of the Danish Seas.† — C. H. Ostenfeld publishes an account of the plankton of the Danish Seas in the years 1898–1901—Phytoplankton and Protozoa. It is the main result of more than ten years' study on the subject, and gives really more than the title indicates, the plankton of later years being also treated. The first chapter, following an Introduction, is a historical review of earlier plankton investigations in Danish seas, and in adjacent seas, by German, Swedish, and Norwegian scientists. Chapter II. describes the conditions of life of the marine phytoplankton, with special regard to the Danish seas, and gives a short survey of the hydrography of these waters. Chapter III. discusses the biology of the plankton organisms : A. The life-cycle and reproduction of the Diatoms, Peridinieæ, Flagellatæ, *Halosphæra*, *Botryococcus*, and Schizophyceæ. B. Adaptations to the planktonic life. C. The periodical occurrence of the plankton organisms ; plankton communities. Here the new terms monacmic and diacmic are proposed for plankton organisms having respectively one, or two, seasonal periods. Chapter IV. contains an enumeration of the species of phytoplankton organisms observed in the Danish seas in 1898–1901, together with remarks on their seasonal occurrence, their distribution, and their dependence on hydrographical conditions. The number of species enumerated is 145, and under each of these is given its regional distribution in the Danish seas ; its seasonal occurrence ; the mean values of the salinity and temperature of the water where it occurs in quantity : remarks on its distribution outside the Danish seas. A series of tables show the seasonal and regional occurrences of the more important species ; and a tabular summary recapitulates the following biological characters for each organism : oceanic or neritic ; holoplanktonic or meroplanktonic : distribution in the Danish seas ; season for minimum or maximum occurrence ; northern, southern, or Baltic distribution outside the Danish seas. A bibliography is appended. A résumé is published in

* Arkiv. för Botanik, xiii. (1913) No. 9, 59 pp. (map and figs.).
‡ Dansk. Vidensk. Selsk. Skrift., ix. (1913) 298 pp. (pls. and figs.). French résumé, 66 pp.

French. An account in English is given by the author in the Bot. Centralblatt.*

Phytoplankton of Victoria Nyanza.†—I. Woloszynska contributes to B. Schröder's "Zellpflanzen Ost Afrikas" an account of the phytoplankton of the Victoria Nyanza. He finds a remarkable prevalence of spiral, ring-shaped, globular, and boat-shaped forms, and an avoidance of straight lines and surfaces. Even the usually stiff *Melosira nyassensis* takes a bow-like curve. *Anabæna flos-aquæ* is twisted like a spiral; and the short filaments of *A. tanganyikæ* are ring-shaped or spiral. The cœnobia of *Scenedesmus* are curved into a half-circle, and the structure is net-like. Membranes surrounded by jelly are a common appearance in Myxophyceæ, Chlorophyceæ, and even in Desmidiaceæ. Peridinieæ are very small. *Ceratium hirundinella* is of middle size, and has three horns. The extreme variability of the plankton forms is remarkable, giving rise to many transition-stages. *Dinobryon* is wanting. Many species appear to have been brought by rivers to the lake. A periodicity seems to exist, but details are not yet forthcoming. Differences in the composition of the plankton of East African lakes are marked, and depend not so much on endemism, as on the respective quantitative relations of the plankton constituents. *Anabæna* and other algæ form no resting-spores. In the Victoria Nyanza there are cosmopolitan species, *Fragilaria virescens*, *Cosmarium depressum*, *Scenedesmus obliquus*, *Anabæna flos-aquæ*, *Peridinium Cunningtonii*; also species peculiar to the temperate zone, and others hitherto only recorded from the tropics. Again, others from the East African lakes, *Surirella malombæ*, *Glæocystis ikapoæ*, *Anabæna tanganyikæ*, *Peridermium africanum*; and, finally, some peculiar to the Victoria Nyanza only, *Rhizosolenia victoriæ*, *Melosira Schroederi*, and *Scenedesmus bijugatus*. The subgenus *Anabænopsis*, common to Africa and Java, is characteristic of the tropical zone. The distribution of the 135 species recorded is shown in a table. New species and varieties are described.

Bacillarieæ of the Lower Elbe.‡—H. Reichelt and F. Schucht report on the diatoms of the recent slime-ooze in the flood area of the Elbe. Samples were collected in 1902 from new stations on the Lower Elbe, and the Bacillarieæ were named by Reichelt. The ooze from Zollenspieker contains remains of fresh-water organisms; and in one of the Hamburg samples fresh-water species predominate, mixed with eight North Sea species and three belonging to slightly brackish water. The samples taken between Schulau and Neufeld b. Marne are rich in diatoms common to the coast-zone of the North Sea in the estuaries of the Elbe, Weser, Jade, Scheldt, and Thames. *Eupodiscus argus*, *Actinocyclus Ehrenbergii*, *Actinoptychus undulatus*, *Biddulphia rhombus*, *Coscinodiscus Jonesianus*, and *Triceratium Favus* are characteristic species. To these may be added the North Atlantic species, *Coscinodiscus oculus-iridis*, *C. radiatus*, and *C. excentricus*.

* Bot. Centralbl., cxxvi. (1914) pp. 619–21.

† Hedwigia, lv. (1914) pp. 183–223 (6 pls. and figs.). See also Bot. Centralbl., cxxvi. (1914) p. 618.

‡ Abh. Nat. Ver. Bremen, xxii. (1914) pp. 259–66. See also Bot. Centralbl. cxxviii. (1915) p. 159.

Bohemian Bacillarieæ.*—K. Hoffman reports on the Bacillarieæ of the Kieselgur and of the marshes in the Soos near Franzensbad, in Bohemia. The Soos marshes are all salt, except those containing *Utricularia*, which are neutral, and are characterized by *Rhopalodia ventricosa* O.M., *Cymbella ventricosa* Kütz., and *C. amphicephala* Nay. The occurrence of *Navicula interrupta*, *N. limosa*, *N. elliptica*, *N. tumida*, and *Achnanthes subsessilis*, characterize the ochreous strata. The Vivianite is poor in siliceous algæ. Characteristic species are: *Nitzschia Kittlii*, *Anomœoneis sculpta*, *Pinnularia viridis*, *Amphora libyca*, *Synedra affinis*, *Gomphonema subclavatum* var. *montanum*, *Melosira crenulata* var. *ambigua*, and remains of *Carnegia*. Experiments were made by the author to ascertain the adaptability of certain species to marshes containing acid-free sulphate; *Nitzschia Palea* won the first place. *Navicula hungarica* was kept in the dark for over two months, and still showed active movements. The great Kieselgur bed is described with the characteristic species of the different depths. *Cymbella gastroides* is wanting, and *Campylodiscus clypeus* predominates. New and critical forms are figured.

Plankton Epiphytes.† — B. Schröder has made a study of the organisms found living on species of plankton, for which he invents the term "Planktonepibionten." Among the phytoplankton, Schizophyceæ and Bacillariaceæ are most frequently found to bear "epibionten," and some of the "epibionten" confine their residence to one particular host-species.

Diatoms of Portugal and Mozambique.—C. Zimmermann‡ publishes a catalogue of the diatoms of Portugal, which includes 459 species; of these fifty-one are new to the country.

The same author § records also diatoms collected by two priests, L. Lopes and M. da Fonseca, in Mozambique. The localities were the rivers Nhamadri, Cathunda, on the Upper Zambesi, and in the Bons Lignaes, or Zuilema, on the Lower Zambesi. The list contains seventy-seven species.

Development of Cylindrocystis.‖—H. Kaufmann describes the development of *Cylindrocystis*. His work is divided into two parts. In the first, the vegetative cell and its division is treated. The nucleo-proteid nature of the nucleus is demonstrated for this class of the Conjugatæ. The vegetative division, which takes place principally at midnight, is described in detail, as well as the division of the chromatophores, with their pyrenoids. The second part of the work deals with the fertilization, ripening, and germination of the zygotes. The union of the two

* Oesterr. Bot. Zeitschr., lxiv. (1914) pp. 209–22 (2 pls.). See also Bot. Centralbl., cxxvi. (1914) p. 481.

† Biol. Centralbl., xxxiv. (1914) pp. 328–38. See also Bot. Centralbl., cxxviii. (1915), p. 297.

‡ Broteria, xii. Ser. Bot., 2 (Braga, 1914).

§ Broteria, xii. Ser. Bot., 3 (Braga, 1914). See also Bot. Centralbl., cxxviii. (1915) p. 267.

‖ Zeitschr. Bot., vi. (1914) pp. 721–74. See also Bot. Centralbl., cxxviii. (1915) p. 344.

gametæ-nuclei takes place immediately after conjugation, before the formation of the mesospore. The nucleus of the mature zygote never shows a nucleolus. It disappears shortly after or even before the fusion of the two gametæ-nuclei, and only re-appears in the germinating plants. Chromatin is finely distributed through the whole zygote-nucleus. During the ripening of the zygote, the stroma-starch and the greater part of the pyrenoid-starch are transformed into oil. The four chromatophores still remain in the zygote, but with diminished circumference. The pyrenoids also degenerate more or less. The membrane of the mature zygote consists of three layers of epidermis. Exospore and endospore are composed of cellules. The mesospore is composed of a basal cellulose material, encrusted with cork-like substance. The division of the zygote-nucleus, at the beginning of germination, is a reduction, and is here described in detail. The four daughter-nuclei remain, and are divided between the four resulting germlings. They rest in the four chromatophores, which then divide. Each pair of daughter-chromatophores, with its respective nucleus, provides one germling. Then the nucleolus appears again in the nuclei of the germlings.

Pediastrum.*—Nitardy publishes an account of the genus *Pediastrum*. The species of *Pediastrum* Meyer, *Micrasterias* Kütz., and of genera of Ehrenberg and Corda are passed in review; also the species included in the publications of later authors. As a result, he includes nine species in the genus *Pediastrum*, which he ranges in five sections. Each species is described. He discusses shortly the floating apparatus of the species. He is of opinion that the bristles and bushy outgrowths are not continuations of the cell-membrane, but are pseudopodia-like prolongations of the protoplasm, which can be withdrawn at will. Finally, the author gives a list of synonomy, a key, a systematic table, and a full bibliography.

Trentepohlia annulata in Moravia.†—S. Prat records the occurrence at Trebitsch, in Moravia, of *Trentepohlia annulata*, growing on the roots, and on sections of the stump, of fir-trees. It grew in small patches and was in fruit. The species is recorded from Bavaria. A detailed diagnosis is given. The specimens were identified by F. Brand, the author of the species.

Tertiary Dasycladaceæ from the Paris Basin.‡—L. and J. Morellet have published a completion and elucidation of Munier Chalmas' preliminary account of the fossil Dasycladaceæ of the Paris basin, which appeared in Comptes Rendus in 1877. Up to the present no continuation has been published, and the eighty-two genera therein enumerated had never been described. The present authors have with great trouble defined all the genera except six, and produced an exhaustive treatment of the forms occurring in the Paris Eocene. The authors have

* Beih. Bot. Centralbl., 2te Abt., xxxii. (1914) pp. 111–94 (10 pls.). See also Bot. Centralbl., cxxviii. (1915) p. 158.

† Oesterr. Bot. Zeitschr., lxiv. (1914) pp. 420–1. See also Bot. Centralbl., cxxviii. (1915) p. 412.

‡ Mem. Soc. Geol. France, xxi. No. 47 (1913) 43 pp. (3 pls. and 24 text-figs.). See also Zeitschr. Bot., vi. (1914) pp. 708–9.

themselves described certain new genera belonging to Dasycladeæ and Bornetelleæ. To the Acetabularieæ belong *Acicularia*, with sub-genera *Briardina* and *Clypeina*. Thereto are joined two groups of somewhat uncertain position with unknown sporangia. Each species of all the genera is fully described and figured.

Bohemian Algæ.* — G. Prat publishes a second addendum to the algal flora of Bohemia, thus bringing up to date the work of Hansgirg. Numerous fresh localities are given for previously recorded species, and one species, *Coconnyxa dispar* Schmidle, is recorded for the first time for Bohemia.

Swedish Marine Algæ.† — H. Kylin writes on the marine algæ in the neighbourhood of Kristineberg, in Bohuslän. Two species, *Erythrocladia subintegra* and *Chantransia reducta*, are here recorded for the first time from the west coast of Sweden.

Cell-contents and Membrane of Characeæ.‡ — A. Votava confirms and completes the investigations of Overton on the structure of Characeæ. He found the typical "Stackelkugeln" (prickly balls) in *Nitella flexilis*, *N. opaca*, *N. capitata*, and *N. syncarpa*; while in *N. mucronata*, *N. hyalina*, *N. gracilis*, and *N. tenuissima*, he found the non-ciliated lumpy ("klumpige") structures. Both show the same reaction to albumen and tannin. Under certain conditions there may appear in all Charæ and Nitellæ numerous centripetal thickenings of the membrane. In the case of chamber-culture this is in most cases to be attributed to impure air. The thickenings may also be caused by an increase of sodium chloride in the water. In numerous rhizoid cells of Characeæ are found large starch-grains of elongated form, sometimes resembling a leg-bone, arranged in spiral rows. Various anatomical details are figured.

Fungi.

(By A. Lorrain Smith, F.L.S.)

Rhizopus Species.§ — J. Hanzawa has studied by culture methods a number of *Rhizopus* moulds, and has arranged them in a systematic series according to their power of fermentation, their growth at low temperature, etc. *Rhizopus nigricans* does not grow at 37° C. The other species recorded do grow at that temperature; but while some of them form sporangia and spores, others belonging to a thermophile group do not form sporangia at low temperatures. Several new species are included in this survey.

After giving in tables the results of his cultures, he discusses the value of his results from a systematic point of view. He compares this

* Priroda, 1914, p. 303. See also Bot. Centralbl., cxxviii. (1915) p. 325.
† Arkiv Bot., xii. No. 10 (1913) 7 pp.
‡ Oesterr. Bot. Zeitschr., lxiv. (1914) pp. 442–55 (figs.). See also Bot. Centralbl., cxxviii. (1915) p. 412.
§ Mycol. Centralbl., v. (1914) pp. 225–46 (12 figs.).

genus of moulds with others, such as *Fusarium* and *Penicillium*, and points out that correct determination of species in these genera also depends on a knowledge of their behaviour in cultures; though there are also morphological characters that are of value in diagnosis—appearance of the rootlets, size of sporangia and spores, and also the marking of these latter.

Syncephalastrum racemosum.*—G. Kita gives an account of this plant, one of the fungi isolated from the air in Japan. Special cultures were made, and the results are set forth. It is nearly related to *Rhizopus*, and has dark rhizoids. A full diagnosis is given, and an account of the growth of the fungus on various substrata. It has not much enzymatic power, and is therefore not economically of use, but it appears in the manufacture of koji, causing a disease named "kuro-toko disease."

Protomycetes of Switzerland.†—Günther von Büren gives a full account of these organisms, with special reference to their life-history and biology. He has made infectious experiments with the spores of the different species, and gives the results of these. He has also embedded the different growth stages, and has cut sections in order to follow the cytological changes. He recognizes as genera of this family, *Protomyces*, *Protomycopsis*, *Volkartia*, and *Taphridium*, all of them well-related to each other. As to this place in regard to other groups of fungi, he compares the cytology of Protomycetæ with that of the Hemiasci, and concludes that the family bears the same relation to Ascomycetes as Ustilagineæ do to Basidiomycetes. The second part of the paper deals with the systematic part of the study, each species being diagnosed in the genera *Protomyces*, *Protomycopsis*, and *Volkartia*. Bibliography and indexes of fungi and hosts follow.

Development in Ascobolæ.‡—G. Ramlow has studied the cytology of reproduction in *Ascophanus carneus* and *Ascobolus immersus*. He gives an account of his methods and of the growth of the fungi in culture media. In both species he found that the normal ascogonium was generally a regularly coiled hyphal branch, which in every part was filled with plasma. With lack of nutrition abnormal formation takes place; the terminal cell becomes prolonged, and the upper ascogonial cells, frequently also the lower, are almost emptied of plasma. The cross septa of the ascogonial cells show openings in the walls which allow the passage of the nuclei. Both the mycelium and the ascogonial cells are multinucleate, and the nuclei pair before the outgrowth of the ascogonial hyphæ. There is no nuclear fusion in the ascogonium: the nuclei remain paired until the ascus is formed, when the fusion only takes place. The nuclei remaining in the crooked ascogonial hypha may repeat the process of ascus formation. In *Ascobolus immersus* the dividing nucleus of the ascus has the same number of chromosomes in the three successive divisions. The author finds that there is no

* Mycol. Centralbl., v. (1914) pp. 126–8 (3 figs.).
† Beiträge Krypt.-Fl. Schweiz, v. Heft 1 (Berne, 1915) 95 pp. (7 pls.).
‡ Mycol. Centralbl., v. (1914) pp. 177–98 (2 pls.).

appearance of two sexual organs, and instead of fertilization by two sexual nuclei there is pairing of nuclei. A comparison is made with the developments of *Thelebolus*.

New Coremium Penicillium.*—F. Boas found this new fungus in cultures of a fungus on *Castanea* fruits. The *Penicillium* not only formed *Coremia*, but also constantly produced a yellow colour-substance. Culture experiments were made on a large series of substrata, and it was found that the *Coremium* formation was more vigorous on dry than on liquid media, otherwise the character of the nutrition was not of great importance, though not wholly without influence. The colour production was very strongly influenced, changing in shade or disappearing altogether. The systematic position is discussed, and Boas finds that it is near to *Penicillium corymbiferum*. He names it *P. Schneggii*.

Notes on Penicillium.†—C. Thom has published notes on the luteum-purpurogenum group of this genus, so called on account of the colours produced in artificial culture media. Morphologically, these species show close affinity; the sterigmata are closely branched, and the branches continue as nearly parallel as mechanical conditions permit. The conidia arise as cylindrical cells; they may become almost globose, but fusiform to elliptical shapes are most common.

Critical Notes on Species of Dicyma.‡—This genus represents the conidial condition of certain species of *Chætomium* or *Myxotrichum*, the conidia being borne in clusters, and the setæ forming the peridium of the fungus. B. Peyronel has examined the species in which *Dicyma* occurs, and proposes to unite them under the old genus *Ascotricha*. There are three of these species.

Stagmospora cassavæ.§—P. C. van der Wolk has described a peculiar mould which gave rise to a disease affecting "young slips of Cassava (*Manihot utilissima*)." It is a wound-parasite, the seat of infection being some cut surface above ground. By tarring all such wounds infection is prevented, and the disease has thus been checked. Cultures of the fungus were made, and Wolk found, in addition to pycnidia of the usual *Stagmospora* type, that endospores were formed within the mycelium, either in rows in the hyphal cells, or in special outgrowths. He came to regard these round bodies as ascospores, and considers that the fungus may be allied to the Protoascineæ.

Uredineæ.—P. Dietel ‖ publishes a note on the cytology of *Uromyces*. In *U. Rumicis* he found that the two nuclei of the teleutospore do not fuse before germination, as they do in other teleutospores. He found the same condition present in *U. Ficariæ*.

O. Treboux ¶ gives the results of various infection experiments.

* Mycol. Centralbl. v. (1914) pp. 73–83.
† Mycologia, vii. (1915) pp. 134–42 (figs.).
‡ Ann. Mycol., xii. (1914) pp. 459–70 (3 figs.).
§ Mycol. Centralbl., v. (1914) pp. 225–30 (10 figs.).
‖ Ann. Mycol., xii. (1914) pp. 422–3.
¶ Ann. Mycol., xii. (1914) pp. 480–3.

He found æcidia on *Ranunculus repens* and *R. flammula*, growing in close proximity. He grew the spores from the latter host on various grasses, and on *Festuca rubra* obtained uredospores and, later, the teleutospores of *Uromyces Festucæ*. He tested the æcidiospores from *Ranunculus scleratus* on a neighbouring plant of *Phragmites communis*, with negative results. Various other cultures on *Ranunculus* are reported. Successful cultures were made on species of *Rumex* and *Rheum* with the spores of *Puccinia Phragmitis*, and cultures with spores of *Puccinia coronata* and *P. coronifera*, with the result that Trebonn does not think there is any sharp limit between the two. With æcidium material from *Rhamnus frangula* he produced the "crown" rust on a number of grasses not before considered as hosts.

P. Dietel * has also published a paper setting forth his views of classification in Uredineæ. He divides them into three families, Melampsoraceæ, Pucciniaceæ, and Pucciniosiraceæ. The first family is the oldest, and were parasites of ferns. They were at first certainly autœcious, but became heterœcious on the appearance of the conifers. The next in time, the Pucciniaceæ, developed through the teleutospore. This group had extraordinary power of development, and many new genera appeared, especially on the Leguminosæ and Rosaceæ—on the former in tropical countries, on the latter in more northern lands. The Pucciniosiraceæ belong almost entirely to the tropics.

Treboux † has also written on the wintering of fungus mycelium, especially of Uredineæ, and cites many instances that have come under his observation. The uredospores scarcely retain germinating power, but leaves containing mycelium may be still living in spring, and be capable of forming new uredospores. He cites as instances *Puccinia dispersa* (on *Secale*), *P. obscura* (on *Luzula*), *P. Poarum*, and others. In these cases he noted on the leaves the old uredo sori, developing new uredospores on the approach of warmer weather.

Ed. Fischer‡ has made a series of culture experiments with the alpine Uredine, *Puccinia Dubyi*. It was found originally on *Androsace Luggeri*, then on *A. alpina*. Many cultures were made, and it was proved that the species was a *Micropuccinia* without pycnidia: that the mycelium penetrated the young shoots, and was probably perennial; and, finally, that it could be transferred to *Androsace carnea*, *A. lactea*, and *A. helvetica*.

Development of Amanitopsis vaginata.§ — G. F. Atkinson has published a study of pileus development, with regard to this species, from very young stages, about 1 mm. in diameter, onwards. In these very young conditions there is already a differentiation into a bulb or foot, and a smaller fertile portion in which the parts of the fruiting tissues originate. The early primordium of the pileus, a biconvex or slightly dome-shaped area near the upper surface, is of slightly denser texture, and stains more deeply. This primordium gradually increases

* Mycol. Centralbl., v. (1914) pp. 65–73.
† Mycol. Centralbl., v. (1914) pp. 120–6.
‡ Mycol. Centralbl., v. (1914) pp. 113–19.
§ Ann. Mycol., xii. (1914) pp. 369–92 (3 pls.).

in size, and three zones can be seen corresponding to the trama, the hymenophore, and the cortex, the whole surrounded by the veil. The development of these different tissues is followed in detail, and the points of difference between this and other Agarics is indicated.

Luminosity in Fungi.*—W. A. Murrill contributes some observations he has made on this subject, though much remains to be learned about the subject. In animals such light is usually brief and intermittent, but certain fungi may give off light continuously for days, weeks, or even months, so long as the light-giving cells are uninjured and active and water is present. Luminosity seems to have no special biological significance in fungi. In general, it seems to be located in actively growing cells, and only in certain parts of the fungus. Murrill gives a list of American species that are luminous, and records his experiences in collecting and watching these species, and the conditions in which they glowed.

Cryptoporus volvatus.†—Notes on the genus *Cryptoporus* are given by S. M. Zeller. It is peculiar in that the pore-bearing layer is hidden by a volva. At first the plants are small globose "buttons" covered with a thick crust of reddish-brown resin from the coniferous trees on which they are parasitic. As the fungus matures an ostiole is formed near the tree-trunk. Successful cultures were made of the first stages, and conidia were produced, but with basidiospores. The relation of the fungus to insects is discussed, and their service in disseminating the spores.

The Genus Muciporus.‡—H. O. Juel has published some observations on *Muciporus*, a genus of Hymenomycetes with a flat wide-spreading sporophore, thickly-crowded pores with a somewhat mucilaginous consistency, and a quickly disappearing hymenium. He describes one of the species, formerly classified as *Polyporus corticola*, generally found in a sterile condition. He found specimens in the spore-bearing stage, and he has described and figured the sterigmata and spores, and the paraphyses or cystidia, generally tipped by a calcium-oxalate crystal.

Contributions to Fungus Floras.—N. Ranogević § gives a third list of fungi collected in Serbia during 1910–11. The present contribution comprises only microfungi; with each species is given the various localities where it was found. Two new genera are described: *Microbasidium*, a genus of Dematieæ, the species of which grow on living leaves of *Sorghum*—it is distinguished by the simple brown spores, and has something of the habit of *Moicladium*. The other, *Dendryphiella*, also one of the Dematieæ, with clustered conidiophores and septate brown spores. In addition, nineteen new species are described.

Otto Jaap ‖ has given lists of fungi from Thuringia; they include

* Mycologia, vii. (1915) pp. 131–3.
† Mycologia, vii. (1915) pp. 121–5 (1 pl.).
‡ Ark. Bot., xiv. (1915) pp. 1–9 (1 pl.).
§ Ann. Mycol., xii. (1914) pp. 393–421 (5 figs.).
‖ Ann. Mycol., xii. (1914) pp. 423–37.

Myxomycetes, Schizomycetes, Phycomycetes, Ascomycetes, Uredineæ, etc. For all of these he has given habitat and locality, and for parasitic species the name of the host. The Basidiomycetes are more shortly dealt with, but this habitat also is indicated. No new species have been discovered.

F. Petrabe * publishes some fungi from Moravia and Austrian Silesia, mostly microfungi. He has established two new genera: *Herpotrichiella*, a Pyrenomycete near to *Acanthostigma*, but with dark spores; and *Leptomassaria*, founded on a species of *Anthostoma*, but differing from that genus in the absence of a stroma. Seven new species are described.

H. Sydow † has published a considerable list of microfungi from Southern India, sent to him by W. M'Rae, most of them collected on the Government farm at Coimbatore. Several new parasitic species are described.

H. and P. Sydow ‡ have also published a very large number of new Philippine fungi, sent for identification by E. D. Merrill. The new genera are *Rizalia*, the species *R. fasciculata* being parasitic on Microthyriaceæ; *Meliolina*, a genus near to *Meliola*; *Pycnoderma*, a genus of Trichopeltaceæ; *Angatia*, a stromatoid Dothideaceæ; *Odontoschizon* and *Manilæa*, minute Discomycetes; and *Exotrichum* and *Psallidosperma*, genera of Excipulaceæ, but with superficial pycnidia. Genera and species are described at length. and their habitat and locality are given.

Philippine Fungi.§—A series of Basidiomycetes have been described by N. Patouillard from Philippine material, more particularly from the Island of Luzon. One new genus has been found, *Duportella*, which is akin to *Hymenochæte*, but with somewhat peculiar cystidia and abundant paraphyses. Representatives of some very rare genera have been described. such as *Elmerina*, not unlike *Hexagona*, but with radiating gills on the under side of the sessile pileus. Diagnoses in Latin of the new species are published, and habitats are given of those already described.

Notes on Australian Fungi.‖—J. Burton Cleland and Edwin Cheel are publishing a series of notes on fungi in Australia, especially the larger fleshy Agarics. The imperfect descriptions hitherto given of many species have rendered the task of identification extremely difficult. Many of the species so carefully described by the authors are British as well as Australian. There is no record as to whether these plants are indigenous or introduced. Four forms of Hymenogastraceæ were met with, and one of the larger Ascomycetes, *Morchella conica*.

Plant Diseases.—F. T. Brooks, F. R. Pethybridge, and G. T. Spinks,¶ have made experiments in the treatment of American gooseberry

* Ann. Mycol., xii. (1914) pp. 471–9.
† Ann. Mycol., xii. (1914) pp. 484–90.
‡ Ann. Mycol., xii. (1914) pp. 545–76 (7 figs.)
§ Philippine Journ. Sci., x. (1915) pp. 85–98.
‖ Journ. Proc. Roy. Soc. N.S. Wales, xlviii. (1915) pp. 433–43.
¶ Journ. Board Agric., xxii. (1915) pp. 227–30.

mildew, by dusting, spraying, etc., to see if any remedy could be used that would take the place of tipping, i.e. cutting off the succulent shoots which became so readily diseased. The results were not favourable to any new method of treatment. Spraying twice in early spring with lime, sulphur, or Bordeaux mixture, checks the disease to some extent, but does not repay the cost of application. All forms of soil-treatment and winter spraying tried appeared to be of no avail in checking the disease during the following season. Heavy farmyard-manuring favours the disease by encouraging the growth of succulent shoots. Tipping the shoots is therefore the most effective means yet devised of reducing the amount of disease, and should be done in autumn, the early part of September being the most favourable period. Diseased fruits should be destroyed as soon as they are noticed.

F. Petch * has compiled a summary of the fungus diseases to which *Hevea brasiliensis* is liable in Ceylon. *Hevea* has been grown under very close supervision, and it has not been found that diseases have increased, and, also, the majority of those diagnosed have not proved serious: one of the worst, indeed, *Fomes semitostus*, is now of minor importance, seeing that the stumps which kept it going are being all weeded out. Petch has divided them into leaf-, stem-, root-diseases, etc., and he gives ample consideration to each group. He winds up with an account of canker, due to *Phytophthora Faberi*, which attacks every part of the tree except the leaves. Advice is given as to the most practical way of treating disease.

Lichens.

(By A. Lorrain Smith, F.L.S.)

New Lichens.†—A. Hue has described a series of lichens that have been collected at various times. There is a new genus, *Nylanderiælla*, the second genus of the family Pyrenothamniaceæ, distinguished by the radiate character of the thallus, with perithecial fruits. The unique species was collected in New Zealand in 1886. He gives a detailed description of *Parmelia tristis*, which he places in the genus *Cetraria*. He makes a number of new species from forms that had been included wrongly in existing species.

* International Rubber Congress, etc., Batavia (1914) 16 pp.
† Ann. Mycol., xii. (1914) pp. 509–36.

Schizophyta.

Schizomycetes.

Formic Acid Fermentation.*—P. Mazé states that formic acid fermentation is due to the presence of a strictly anaerobic organism which bears a morphological resemblance to a *Sarcina*, and that the fermentation in question is characterized by the production of carbonic acid gas and formic acid. When fermentable media, containing calcium carbonate, with either neutral or alkaline reactions, are inoculated with either particles of manure, vegetable mould, arable earth, liquid manure, or drain- or river-water, and placed in the incubator at 30°C., a butyric acid fermentation takes place. After several days the butyric acid fermentation is arrested somewhat abruptly, and formic acid commences to appear in the medium, coincident with the growth of the specific formic-acid producing organism. The ferment will not, however, grow in pure culture, and is always found in symbiotic association with organisms causing butyric acid fermentation.

The organism grows well in a medium containing saccharose broth to which small quantities of various organic and inorganic salts have been added (chloride of ammonia, phosphate of potash, sulphate of magnesium, iron, zinc and manganese, silicate of potash, lactate of calcium, acetate of calcium, etc.). The medium is inoculated with manure, and at the end of some hours a mycelial scum develops on the surface of the liquid, thus giving the necessary anaerobic conditions for the growth of the specific ferment.

Fatal Gas-gangrene caused by the Bacillus "Neigeux."†—S. Costa and J. Troisier record a case of fatal gas-gangrene in a wounded soldier, in which the causal organism was neither the *Bacillus perfringens* nor the *B. œdematis maligni*, although the clinical syndrome was highly suggestive of infection by these organisms. From the serum exudate of the patient was isolated a bacillus of the *perfringens* type, non-motile and without spores. It was Gram-positive, from 4–6 μ in length and about 1 μ in thickness. The characteristic colonies appeared in Veillon's agar, forming whitish masses of flocculent aspect, resembling flecks of snow. No growth took place in liquid media.

All the appearances of the organism indicated its identity with the *B.* "*neigeux*" Jungano. This organism, which is a normal inhabitant of the urinary passages, is therefore to be added to the list of bacteria which are able to act as causal agents in gas-gangrene infection.

Bacteriology of Malignant Œdema.‡—E. Sacquépée describes an organism which he has found in association with a peculiarly virulent type of malignant œdema, which has been called "œdème gazeux malin."

Morphologically, the bacillus found in the exudate and pathological

* C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 398–405.
† C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 352–5.
‡ C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 316–8.

tissues is straight or slightly curved. In cultures the organisms are very polymorphic, sinuous and filamentous forms occurring. The bacilli are generally isolated, but sometimes they form short chains. The extremities are blunt. The bacillus is readily stained by aniline dyes, but retains the stain in Gram's method with some difficulty. The motility which it exhibits in pathological exudates is lost in growth in liquid media. The organism forms spores; the spores are oblong or egg-shaped, almost always terminal or sub-terminal, more rarely central. After twenty-four hours on Veillon's agar the colonies appear as small points, visible to the naked eye. When magnified they appear to possess a brownish-yellow central mass surrounded by a clear halo of irregular outline. The cultures in glucose broth have a putrid odour. Spores are formed in ordinary broth, less so in lactic broth, and not at all in glucose broth. Milk, to which calcium carbonate has been added, is coagulated in two or three days, the casein clot undergoing progressive digestion. The organism is very virulent for the guinea-pig.

Biological Researches on the Eosinophiles.*—M. Weinberg and P. Séguin have conducted an important research on the biological properties of the eosinophile leucocytes. They have shown that these cells possess phagocytic properties, being capable of ingesting inert matter (animal black), and of phagocyting many species of bacteria and protozoa, and also red blood corpuscles. The organisms used in their experiments included staphylococci, sarcinæ, streptococci, gonococci, meningococci, *Bacillus anthracis*, *B. Coli*, *B. diphtheriæ*, *B. tetragenus*, *Monilia allicans*, *Sporotrichum Beurmanni*, *Spirochæta gallinarum*, *Heteromita cariæ*, and *Trypanosoma Evansi*. The experiments were conducted either in vitro, using guinea-pig leucocytes, or in vivo (peritoneal cavity of the guinea-pig, subcutaneous tissues, circulating blood, etc.). From experiments conducted with *B. subtilis*, *B. coli*, protozoa and red cells, it was concluded that the eosinophiles were not only able to engulf but could also digest these elements. When the eosinophiles are very abundant in the blood, or when they accumulate at the seat of inoculation, they play an important rôle in the immediate protection of the organism against infection.

Although the eosinophiles possess the various properties above enumerated, they only play a subsidiary rôle in phagocytosis, their principal function being the absorption of toxic products. When eosinophile leucocytes were placed in contact with the fluid from a hydatid cyst for a period of one hour, it was found that they no longer exhibited their phagocytic properties, although the other leucocytes present (neutrophiles and mononuclears) remained capable of ingesting bacteria. The eosinophiles possess the power of absorbing hydatid fluid, the fluid in question losing its antigenic properties when placed in contact with an appropriate number of eosinophiles. This fact is easily demonstrated by use of the complement-fixation reaction with a fresh echinococcus serum, normal hydatid fluid being used as a control. The eosinophiles of immunized animals absorb the hydatid antigen more easily than the eosinophiles of normal animals.

* Ann. Inst. Pasteur, xxix. (1915) pp. 323–45 (2 pls.).

"Sottō" Bacillus of Silkworms.* — K. Aoki and Y. Chegasaki have studied the question of the pathogenicity to silkworms of Ishiwata's "Sottō" bacillus. The bacillus in question was first described by Ishiwata in 1902, the name "Sottō" meaning "sudden infection" in Japanese.

When old agar cultures of the Sottō bacillus are administered to silkworms *per os*, the animals almost invariably die within three hours, this result being brought about through the operation of a toxin elaborated by the bacillus before its introduction, and not through any multiplication of the organisms themselves. If young agar cultures are introduced in large masses, the bacilli, which are relatively atoxic, die out in process of time, and the experimental silkworms are not affected. When worms treated with old cultures manage to survive for a period of from ten to fifteen hours, multiplication of the organisms may be observed in the hæmolymph system, but not in the digestive tract. The germs that are still present in the alimentary canal show commencing degeneration. The invasion of the hæmolymph system may be explained on the supposition that the resistance of the silkworm is lowered by the action of the bacterio-toxin introduced along with the bacillus. The organism displays particular virulence when it is introduced directly into the hæmolymph system, and in this case the age of the culture does not exercise any influence.

Leptothrix in Pure Culture †—Y. Kato places on record a case of pleuro-pneumonia caused by leptothrix infection, in which the striking symptoms were fever of long duration, cough, and expectoration. The patient died finally of heart failure. The sputum was throughout of a mucous character, never purulent or blood-stained, and was devoid of elastic fibres or tissue elements. It contained abundant whitish or grey-white leptothrix granules of various shapes and sizes, and was free from *Bacillus tuberculosis* or other pathogenic organisms. The granules were round or elliptical, and consisted of three elements—threads, rods, and micrococci. The threads and rods were unbranched and articulated, were Gram-negative, and did not exhibit spores, flagellæ, or polar bodies. The organisms were easily obtained in pure growth on various culture media, but especially on media containing sugar or glycerin; such pure cultures also consisting of threads, rods, and micrococci. This pleomorphism was especially noticeable in old cultures.

The leptothrix granules and the derived cultures were found to be pathogenic for mice and guinea-pigs—the inoculated animals dying of chronic septicæmia—but were devoid of pathogenicity for rabbits and monkeys and for cold-blooded animals (frogs, goldfish, etc.). Toxin production was never observed.

The immune serum of rabbits, inoculated with the leptothrix, agglutinated the leptothrix, but not other organisms. No agglutination was observed with normal human serum.

* Mitteil. aus der Med. Fakult. der Kaiserlichen Univ. zu Tokyo, xiii. (1915) pp. 419–39.

† Mitteil. aus der Med. Fakult. der Kaiserlichen Univ. zu Tokyo, xiii. (1915) pp. 441–7.

Bacillus hemiphloiæ.*—R. Greig-Smith has recently discovered a new levan-gum forming bacterium. The author had previously described *Bacillus levaniformis* and *B. eucalypti*, the first of which does not form spores, and the latter ferments certain sugars with evolution of gas. The gum, obtained by growing the bacterium in saccharose-pepton fluid and coagulating with alcohol, had all the chemical and physical properties of levan-gum. Like *B. levaniformis*, the microbe could act on unheated saccharine solutions, and, like *B. eucalypti*, it can cause a fermenting gum-flux of certain eucalyptus trees. *B. hemiphloiæ* measures 7 μ in breadth, and from 0·8–1·7 μ in length. It is actively motile and possesses one to nine peritrichal flagella. On most media the growth is raised and white. Milk is coagulated. It forms indol and reduces nitrates to nitrites. On saccharose-pepton fluid there is formation of levan-gum and inversion of saccharose. In dextrose, saccharose, and lactose media, acid and gas are formed.

* Proc. Linn. Soc. N.S.W., xl. (1915) pp. 174–5.

MICROSCOPY.

A. Instruments, Accessories, etc.*

(1) Stands.

Microspectroscope in Mineralogy.†—E. T. Wherry thinks that the possibilities of the microspectroscope in the identification of minerals and in the study of their composition have apparently not been generally appreciated by mineralogists, and his paper comprises descriptions of the spectra of a much larger number of minerals than have heretofore been examined. The apparatus he found most satisfactory was a Crouch binocular Microscope stand, fitted with a 37-mm. objective, an Abbe-Zeiss Spektral-ocular in the right-hand tube, and in the other an ordinary low-power eye-piece, marked on the lower lens at the point where the image of a mineral grain falls when it is visible through the spectroscope slit. The prism which diverts part of the light into the left-hand tube is withdrawn after the mineral grain has been centred, so as to permit as much light as possible to pass through the spectroscope. A binocular Microscope is not absolutely necessary, but frequent re-adjustments of the scale and slit have to be made if the mineral is observed by swinging out the upper part of the spectroscope and the slit-holder. Light may be obtained from any source yielding a brilliant white light, such as a Welsbach burner or a Nernst lamp, although sunlight or daylight are objectionable on account of the Fraunhofer bands. For the study of minerals in thin sections the light is reflected up through the specimen, but in the majority of cases better results are obtained by concentrating the light laterally on the specimen by a lens or by a parabolic mirror and observing the brightest portion of its path. Not only does the latter plan yield the better spectra, but it permits the examination of crystals on the matrix, and gems in their settings. To set the wave-length scale of the instrument accurately, a sodium flame is used, scale-division 058·9 being brought into coincidence with the yellow (D) line. In addition, a small slip of didymium glass, which can be readily inserted at the opening where light for the comparison spectrum enters, is very convenient, the interval between the strong-absorption bands of neodymium and praseodymium in the yellow being set at about 058 (580 $\mu\mu$). The scale of the instrument is graduated in hundredths of mikrons, but, except at the extreme red end, tenths of divisions can be readily estimated, and it is most convenient to state measurements in three-figure wave-lengths. The light diffused by mineral grains shows in most cases more intense absorption-bands than that transmitted through them, yet it must penetrate considerably to be

* This subdivision contains (1) Stands; (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Smithsonian Misc. Coll., lxv. No. 5 (publ. 2362).

affected at all, so that only transparent or fairly translucent minerals yield any effects; in addition, they must be more or less distinctly coloured. The number of minerals suitable for microspectroscopic study is therefore rather limited, but the fact that the specimens need not be scratched, broken, or altered in any way renders the method of considerable use in the identification of crystals too valuable to be broken up for the usual tests. Even when other methods are applicable, the spectra may serve as confirmatory tests. The author discusses in detail the spectra of the rare-earth minerals, the uranium metals, and the garnet group. He tabulates the result of the microspectroscopic examination of about 200 minerals.

(2) Eye-pieces and Objectives.

Novel Pseudoscopic Eye-piece.*—J. Strong discusses a rough-and-ready pseudoscopic eye-piece which gives very beautiful and striking effects. A cardboard or stiff paper tube, 2 in. long, is fitted on to the outside of the draw-tube of the Microscope. Outside this is another tube, 7 in. in length, sliding somewhat stiffly and carrying at its upper end a diaphragm with a $\frac{3}{4}$-in. aperture. The short inner tube carries at its upper end a single meniscus lens, fixed convex side uppermost, and of focus about 4 in. This particular lens has nearly all the faults a lens can have, but the designer thinks that the pseudoscopic effect is due to these very faults. The insides of the tubes should, of course, be blackened. With this simple apparatus the author gets magnificent views of Foraminifera, Radiolaria, Rotifers, and all large "binocular" objects.

Zeiss' "New" Object-glass.†—With reference to this auxiliary, which was described by E. M. Nelson in the November number of the Journal of the Quekett, and noticed in this Journal in April last,‡ J. W. Gordon points out that the lens is not so novel as Nelson supposed, inasmuch as one of identical design was made in 1909 by Messrs. R. and J. Beck to Gordon's order, and was exhibited at the Optical Convention in 1912, and was fully described in the Convention Catalogue.

In the same paper the author points out the advantage to be gained by the following extension of the principle involved in the construction of this lens. He mounts a hemispherical lens on a cover-glass enclosed in a shallow brass ring, which enables the observer to move the whole article about and place it where required; it thus functions to some extent as a finder. If, now, the specimen with this supplemental lens be brought into position under a dry objective, a combination is obtained precisely such as Nelson desires. It will be noticed that it is not necessary to make any corrections for colour or for spherical aberration, because if the lens is of the right thickness, so that the centre of its spherical surface coincides with the focal point, then the incident beam passes the air-glass surface of the lens without refraction, and therefore without aberration of any kind. The cost of the auxiliary would be very

* English Mechanic, ci. (1915) pp. 536–7 (1 fig.).
† Journ. Quekett Micr. Club, xii. (1915) pp. 515–20 (2 figs.).
‡ Pages 178–9.

small, and, moreover, it possesses the very great merit of getting rid of the top light reflected down upon the surface of the object by the upper surface of the cover-glass.

(3) Illuminating and other Apparatus.

Magnesium Flash-light for Zoological Work.* — W. E. Watson-Baker, in a paper read before the Photomicrographic Society, called attention to a new source of light he had seen described by S. B. Doten in an American publication on photography called "Camera Craft." The method was suggested by the fact that a small quantity of magnesium-flash powder may give light equivalent to full sunlight upon an object 6 ft. away from the flame. But the comparative slowness of the magnesium flash stood in the way of perfect success. Further attempts were therefore made by Doten, all depending on developing a flame by the electric vaporization and ignition of a fine wire in free air. The apparatus finally adopted was as follows. A little block of J. M. Transite asbestos-wood carries two brass binding-posts $\frac{3}{8}$ in. in diam. and 1 in. high, with rounded tops. A strand of No. 31 B. and S. gauge silver or copper wire is clamped beneath them, like a fuse in a branch-block. A knife-switch, whose blade may be thrown into contact at will very suddenly by a pneumatic release and a steel coil spring, shoots a heavy current through the fuse, which is instantly vaporized; the vapour springs up from a slot in a block of transite placed over the posts. The vapour shoots beyond the tops of the posts, while from the top of each a jet of vapour pours out which is far more luminous than that from the wire itself. It was found that this flame is cold in the sense that it will not burn the hand. It is clear, smokeless, clean, and most intensely brilliant. Many sorts of fuse-wire—copper, silver, lead, aluminium, magnesium, and carbon—were tried between posts of brass, carbon, and magnesium. On the whole, the 1-in. length of magnesium wire between brass posts $\frac{3}{8}$ in. in diam. and 1 in. high would seem to be the best of all. With direct current of 110 to 120 volts all the metals tested between any of the posts give flames uniformly sure and brilliant.

(4) Photomicrography.

SENIOR, E.—**Some Interesting Experiments in Photomicrography.**
[Under the above title the author describes the apparatus, adjustments, accessories, and general details necessary for successful photomicrography.] *Journ. Photomicr. Soc.*, iv. (1915) pp. 52–8 (many figs.).

(5) Microscopical Optics and Manipulation.

Theory of Diffraction in Relation to the Theory of Optics.†—J. W. Gordon, in a lecture before the Photomicrographic Society, suggested the term "perioptrics" as suitable for the study of the diffracted image, and considered that it ranked equally with dioptrics and catoptrics as main divisions of the theory of optics. After indicating by an experi-

* Journ. Photomicr. Soc., iv. (1915) pp. 40–2.
† Journ. Photomicr. Soc., iv. (1915) pp. 33–40 (1 fig.).

ment how the brightness of diffracted light may be estimated, and on what view of the nature of light-propagation it is possible to explain the appearance of diffracted light in the region of the geometrical shadow, the lecturer gave a short review of the history of perioptrics. Grimaldi, in the middle of the seventeenth century, was the first writer on the subject, but his results were of no particular value, because he did not succeed in determining the essential nature of diffraction. Newton, in his "Opticks," was aware of the incompleteness of his own researches, but the "queries" which he propounded for others to solve were so worded as to suggest that he thought gravitation was responsible for the bending of light-rays round bodies, especially when in close proximity. Newton's influence in this department of physics was predominant for 150 years, although Huyghens had laid the foundation for the next step in advance by explaining that the propagation of light is due to the interference of wave-impulses starting from the surface of a wave-front. In 1816 Fresnel contributed to the French Academy his celebrated exposition of the law determining the form of the diffraction pattern. As he dealt only with unfocused light, the diffraction pattern deducible by Fresnel's own method is that at infinity. The first writer to explore the phenomena of diffraction in the focal plane was Fraunhofer, whose paper on the subject was contributed to the Berlin Academy about the year 1830. Curiously enough, although Fraunhofer was writing ten years after Fresnel's great paper, he seems to have been unaware of it. The work of Fresnel and Fraunhofer in a manner, somewhat unsystematically, covered the whole field of diffraction phenomena, but they left one very important region of it undeveloped, viz. the diffraction pattern of a circular aperture. This practical problem was simultaneously solved, in 1835, by Airy in our own country and by Schwerd in Germany. In 1873 Helmholtz, by a very bold and elegant generalization, brought the Fresnel and Fraunhofer phenomena into a mutual inter-dependent relationship by proving that the diffraction image in a focal plane is simply the conjugate to that image at infinity. If, then, we know what is the image at infinity which any given aperture will yield, we have only to apply the law of optical projection, and thereby determine its image in a given focal plane. Strangely enough, Helmholtz' demonstration has not yet found its way into the text-books, and notwithstanding the value and elegance of the theorem it is still practically unknown to writers on the subject of perioptrics.

Although the theory of the diffraction image is now in a sense complete, it still lacks practical handiness. The mathematical difficulties of integration are very considerable, but the lecturer suggested a method whereby, if the enveloping surface of the aplanatic cone were taken as the radiant surface, the process of integration could be much simplified; and in the most important case, that of a circular aperture, nothing more abstruse than trigonometrical functions would be required.

Accurate Measurement of the Refractive Indices of Minute Crystal Grains under the Petrographic Microscope.*—F. E. Wright discusses this subject, and the following is his summary of his remarks.

* Washington Acad. Sci., v. (1915) pp. 101–8.

In the exact measurement of refractive indices of minute crystal particles by the immersion method it is essential:—1. That correctly-oriented sections be selected which are normal to at least one principal optic section. 2. That in case oblique illumination be used, only those pencils of light be employed whose direction of propagation is included in the plane normal to the principal optical section: in other words, the metal sliding-stop should be so inserted that its front edge is parallel to a principal section. 3. That with central illumination special weight be given to the effects along those edges of the grain which trend approximately parallel to the principal section. If these conditions be disregarded, the value obtained for the maximum refractive index will be too low, the value for the minimum refractive index too high, while that of any intermediate refractive index, as β, may be too high or too low. Failure to recognize these factors may lead, especially in the case of strongly birefracting crystal particles, to refractive index determinations which are appreciably in error.

B. Technique.*

(1) Collecting Objects, including Culture Processes.

Culture Media for the Isolation of Cholera.†—O. Lentz has found that dried Dieudonné's blood agar gives bad results in the isolation of cholera vibrios, owing to the binding of the free alkali by the serum proteins of the medium. In the following method, which gives excellent results, the blood-alkali mixture is dried apart from the agar. Fresh defibrinated ox-blood is mixed with an equal quantity of normal potash, and then steamed for half an hour. The liquid is then evaporated in shallow trays under an air current at 37° C., the residue being ground to powder and kept in a stoppered bottle. Three grains of powder are dissolved in 30 c.cm. water and are added to 70 c.cm. neutral agar.

H. Violle ‡ uses the following medium for the isolation of cholera vibrios in preference to Dieudonné's blood agar:—Nutrient agar 87 parts, glycerin 10 parts, normal soda 3 parts. The medium is easily prepared, keeps well, and is transparent, enabling the observer to distinguish the cholera colonies as small transparent, somewhat rounded, pin-head growths. The vibrios are somewhat short and plump and less motile than normally; nevertheless, they are easily recognizable and retain their staining properties. Two p.c. pepton-water can be substituted for the nutrient agar, and a good liquid medium thus obtained.

* This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Imbedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, etc.; (6) Miscellaneous.

† Dent. Med. Woch., xli. (1915) pp. 425–6.

‡ Bull. Soc. Path. Exot., viii. (1915) pp. 52–4.

(4) Staining and Injecting.

New Staining Methods for Blood Smears.*—W. J. MacNeal and P. A. Schule point out that the Romanowsky stain and its various modifications possess the ability to differentiate chromatin by virtue of the presence of both methylen-azure and methylen-violet. The combination of methylen-azure with eosin seems to decompose in alcohol, with oxidation of the latter.

The authors suggest the preparation of two permanent reagents, the one containing eosin and the other methylen-blue and its derivatives. Two stock solutions were prepared as follows:—

Solution A—

Eosin, water soluble, yellowish . .	1
Methylic alcohol, Merck's "Reagent" .	500

Solution B—

Methylen-blue, medicinally pure . .	1
Methylen-azure	0·20
Methylen-violet, commercial . . .	0·60
Methylic alcohol, Merk's "Reagent" .	500·00

"The dyes are thoroughly rubbed up in a perfectly clean mortar with a few drops of the alcohol, so as to form a homogeneous paste. This is then transferred to a bottle (capacity 500 c.cm.), and the mortar is carefully washed clean with successive portions of methylic alcohol, which are subsequently poured into the bottle. The remainder of the 500 c.cm. of methylic alcohol is added, the bottle thoroughly shaken, stoppered loosely, and immersed in warm water (50° C.) for a time, and again thoroughly shaken. It is well to keep it in a warm place for a few days, shaking it at frequent intervals so as to separate the dyes from the insoluble residue and bring them completely into solution. Filtration is unnecessary. These solutions are kept in amber bottles in a dark place, and remain in good condition for several months. Small equal portions (30 c.cm.) are mixed together to form the staining solution, which is then ready for immediate use and keeps well for a few weeks.

"The staining method is that described by Leishman, and already too well known to require more than a hasty description. To a freshly-made thin, dry blood-film one adds the staining solution, allows it to stand one minute; then dilutes with about an equal amount of distilled water, and allows this resulting mixture to act for two to three minutes; then washes in distilled water until the desired differentiation is reached, and dries the preparation between filter-papers. If the preparation is to be mounted in balsam or cedar-oil, it should be very thoroughly dried, best by standing for a day in the incubator, before mounting it."

* Post Graduate, Nov. 1913, 6 pp.

Metallography, etc.

Iron, Carbon, and Phosphorus.* — J. E Stead has collected and summarized his more recent work on iron-carbon-phosphorus alloys. The investigations and observations described are of varied character, dealing not only with the equilibrium of the ternary system, but also with numerous practical questions arising from the presence of phosphorus in commercial iron and steel. The cause, effects, and detection of the unequal distribution of phosphorus in iron and steel are fully considered. The cupric reagent which has been successfully used by the author for indicating phosphorus segregation is made by mixing:— Cupric chloride, 10 grm.; magnesium chloride, 40 grm.; hydrochloric acid, 20 c.cm.; alcohol to make up to 1000 c.cm.

The salts are dissolved in the least possible quantity of hot water, and the hydrochloric acid and alcohol then added. The polished specimens are covered with a thin layer of the reagent, and must not be immersed in a bath of the solution. After one minute's action, the layer of reagent is shaken off and a second layer is applied and allowed to act for the same length of time. This is repeated until the desired effect is obtained. The specimen is washed with boiling water and dried off with alcohol. The effect of the reagent is to deposit copper on the purer parts of the steel first, the regions containing more phosphorus remaining bright, but as the action of the reagent continues the copper deposit gradually forms on the less pure parts also. Thus by the progressive etching described much information may be obtained as to the degree and distribution of the phosphorus segregation. The regions richest in phosphorus are always the last to be affected by the reagent. As the action of this and similar copper reagents depends on the relative solubility of different parts of the metal in dilute acid, and as other elements present in solid solution affect the solubility in the same way as phosphorus does, unequal distribution of nickel, copper, arsenic, chromium, tin, and antimony, if present in the steel, may be indicated by the reagent, and may possibly lead to an erroneous assumption of phosphorus segregation.

In iron free from carbon the phosphorus tends to be uniformly distributed. As the carbon in the fluid metal increases, the phosphorus becomes more and more concentrated in the portions last to solidify, and in highly carburized irons the whole of the phosphorus is concentrated in the last-solidifying portions. At the temperature of final solidification of steel, the last-solidifying portions have a high-carbon as well as a high-phosphorus content. In the subsequent cooling, the carbon is driven out of the high-phosphorus regions, and in low- and medium-carbon steel ferrite bands are produced. When such local absence of carbon becomes sufficiently pronounced, the carbonless streaks termed "ghosts" are formed. As sulphur commonly segregates

* Journ. Iron and Steel Inst., xci. (1915, 1) pp. 140–98 (77 figs.)

with phosphorus, the ferrite bands or ghosts frequently contain excessive quantities of sulphide inclusions. The presence of such inclusions embedded in ferrite has given rise to the mistaken view that the inclusions are the cause of the ghosts, having acted as centres of crystallization for the ferrite. The true cause of ghosts is the tendency of the carbon, when in solution, to leave the high-phosphorus regions and to concentrate in the low-phosphorus parts, during cooling. At temperatures little below the solidus, the point of incipient fusion, phosphorus diffuses and in time becomes uniformly distributed in steel, but at lower temperatures diffusion is very slow. The unequal distribution of phosphorus also retards somewhat the diffusion of carbon in steel when heated above the critical range. When a steel, heated above the critical range, has its carbon uniformly diffused, but its phosphorus varying in concentration from point to point, ferrite first forms on cooling in the regions of maximum phosphorus content. Thus ghosts may reappear after repeated heating to high temperatures.

The heterogeneous character of wrought irons, through unequal distribution of phosphorus, has been indicated by the cupric reagent.

The paper is illustrated with numerous photomicrographs, some of which are reproductions in colour of colour-photomicrographs of heat-tinted specimens.

Detection of Burning in Steel.*—The heating of steel to such a high temperature that it cannot be rolled or forged without breaking up is technically known as "burning," and is coincident with incipient fusion. J. E. Stead has previously shown that when incipient fusion occurs the portions which melt first are rich in phosphorus, and persist after cooling as globules or envelopes round the crystals. He has now applied the new cupric reagent (see preceding abstract) to the detection of these minute high-phosphorus segregates, the presence of which is an unfailing indication that the steel has been "burnt." A steel plate containing a layer of segregate (carbon 0·5, phosphorus 0·13) sandwiched between layers of purer material (carbon 0·3, phosphorus 0·07 p.c.) was heated at one end until that end melted. After cooling, sections were cut at parts heated to different temperatures. The globules and envelopes first appeared in the central high-phosphorus region, showing that the less pure material became burnt at a lower temperature than the outer and more pure layers. Burning is not in any way an effect of oxidation, but may cause the formation of cracks which oxidize very rapidly.

Ancient Iron from Ceylon.†—W. Rosenhain has examined a small fragment of a link from a chain which had hung in the open air in Ceylon for probably more than two thousand years. Polished sections showed included slag much resembling that present in common wrought-iron, but drawn out to a less extent. All etching reagents tried were found to be slower in their action on the Ceylon iron than on modern Staffordshire wrought-iron, suggesting a lesser corrodibility of the ancient iron. The etched sections presented the usual features of

* Journ. Iron and Steel. Inst., xci. (1915, 1) pp. 398–408 (17 figs.).
† Nat. Phys. Lab. Collected Researches, xii. (1915) pp. 153–60 (5 figs.).

modern wrought-iron. The good state of preservation of the iron was probably due to a protective coating of slag.

Lack of Uniformity in Steel Bars.*—In the course of experiments on the tensile testing of reinforcing bars, E. P. Withrow and L. C. Niedner have shown by microscopical examination that the axial region of some of the specimens contained more carbon than the outer layers. The removal of the outer layers by machining accordingly increased the relative strength of the bar.

Sulphides in Steel.†—J. O. Arnold and G. R. Bolsover describe the microscopic forms assumed by the sulphides of manganese and iron in a further series of experimental steel ingots. The appearance and nature of a eutectic-like structure, apparently consisting of manganese sulphide and iron, are discussed.

Internal Fissure in a Steel Axle.‡—R. Job describes a microscopical investigation which led to the conclusion that an internal transverse oxidized crack in a large steel axle had been caused by stresses, set up by faulty heat-treatment, acting on unsound steel.

Diffusion of Carbon in Iron.§—F. W. Adams has heated low-carbon material such as Swedish iron and mild steel, in contact with high carbon steel or cast-iron, in a vacuum, at 900°–1000° C., to determine by the gains and losses in weight, together with the percentage gains and losses of carbon, whether carbon diffuses in the form of carbide or as elemental carbon. The surfaces in contact were previously polished. It was found that no diffusion of carbon occurred unless welding or inter-crystallization took place ; thus a determination of the change in weight of each specimen became impossible when carbon diffused from one specimen to the other.

Iron-silicon-carbon Alloys.‖—G. Charpy and A. Cornu-Thenard describe their thermal, microscopical, and chemical investigation of the effect of silicon in iron-carbon alloys. Silicon has a marked influence on the thermal critical points, strongly promotes the separation of graphite, and lowers the solid solubility of carbon in iron at high temperatures.

Annealing of Grey Iron Castings.¶—G. S. Evans describes the softening effect and the changes in microstructure occurring when small grey iron castings are annealed at temperatures not below 700° C. This treatment causes a reduction in the percentage of combined carbon, additional graphite being precipitated by decomposition of carbide of iron.

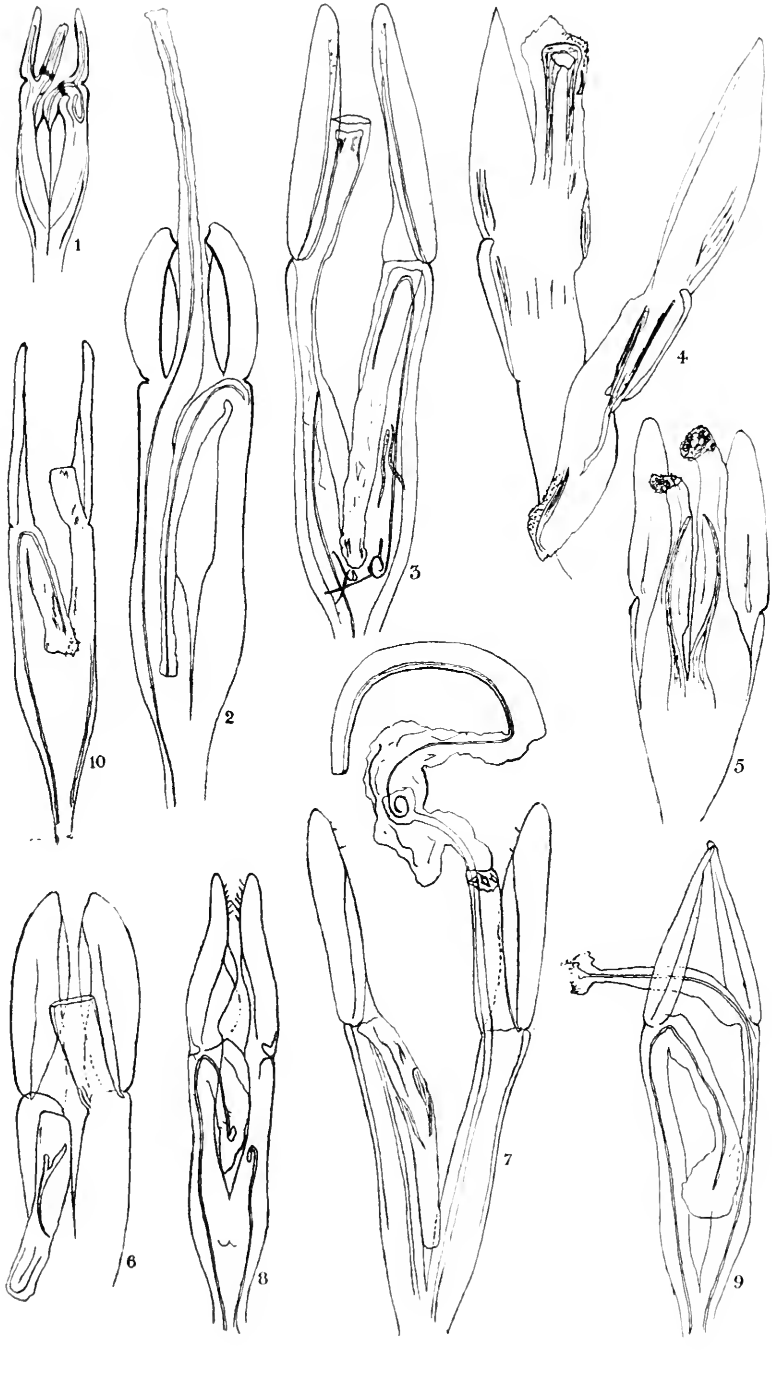
* Proc. Amer. Soc. Testing Materials, xiv. (1914) pt. 2, pp. 90–109 (25 figs.).
† Journ. Iron and Steel Inst., xci. (1915, 1) pp. 271–5 (4 figs.).
‡ Proc. Amer. Soc. Testing Materials, xiv. (1914) pt. 2, pp. 76–89 (9 figs.).
§ Journ. Iron and Steel Inst., xci. (1915, 1) pp. 255–70 (11 figs.).
‖ Journ. Iron and Steel Inst., xci. (1915, 1) pp. 276–305 (32 figs.).
¶ Foundry, xliii. (1915) pp. 219–21 (9 figs.).

Surface-flow.*—Cast-iron wearing surfaces, such as the bore surfaces of steam and internal-combustion engine cylinders, give the least trouble and the most endurance after they have become "glazed" by use. J. E. Hurst states that such hard glazed surfaces are fine examples of surface-flow, and gives photomicrographs illustrating their formation. The thickness of the flowed layer may be 0·005–0·01 mm. The hard layer is attacked only slowly by nitric acid. The cast-irons studied consisted mainly of ferrite and pearlite, with hard phosphide eutectic and graphite plates. Wear causes the phosphide eutectic to stand in relief. The hard flowed surface layer formed appears to consist of the amorphous phase of ferrite, together with some amorphous product of the hard phosphide eutectic, and possibly other constituents.

Gold-cadmium Alloys.†—P. J. Saldau finds that gold and cadmium form two compounds, AuCd and $AuCd_3$, giving solid solutions with their components within certain limits. Gold and AuCd, and cadmium and $AuCd_3$, form solid solutions containing, respectively, up to 35 atomic p.c. of cadmium and 2 atomic p.c. of gold.

Preparation of Metal Specimens.‡—The Wysor combined grinding and polishing machine, recently placed on the market by Eimer and Amend, New York, is described. The carborundum grinding wheels are carried on the horizontal shaft, the roughing wheel being on one end and the medium and finishing wheels on the other end. The polishing disks are of brass with cloth coverings, and are easily replaceable on the head of the vertical spindle, which is driven by contact with a friction wheel on the horizontal shaft. The speed of rotation of the polishing disks may be varied by shifting the friction wheel on the shaft. After grinding, the specimen is polished in turn on (1) canvas with emery flour, (2) broadcloth with tripoli, (3) broadcloth with rouge. The polishing powders are mixed with water to the consistency of flowing paste; glass bulb-holders are used for applying the pastes to the disks. The machine appears to be compact and convenient.

* Engineering, c. (1915) pp. 130-1 (5 figs.).
† Journ. Russ. Phys. Chem. Soc., xlvi. (1914) pp. 994-1027, through Journ. Chem. Soc., cviii. (1915) p. 353.
‡ Met. and Chem. Eng., xiii. (1915) pp. 400-1 (2 figs.).



Face p. 521.]

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TRANSACTIONS OF THE SOCIETY.

VIII.—*On the Male Genital Armature of the Dermaptera. Part II.: Psalidæ.*

By Malcolm Burr, M.A. D.Sc. F.L.S. F.E.S.

Communicated by John Hopkinson, V.-P. R.M.S. (*Read May* 19, 1915.)

Plates X to XII and Figs. 58 to 64.

PSALIDÆ.

As Zacher remarks, the classification of this group is one of the most difficult of the taxonomic problems offered by the Dermaptera.

The best solution tendered yet is that of Zacher, based almost exclusively on the genital armature of the male; these certainly offer extremely valuable specific and generic characters, but he did not have sufficient material at his disposal to enable him to judge the relative value of the different features. He observes that very useful characters are afforded by the form of the pronotum, and of the antennæ, both of which are of generic value, of the structure of the end of the abdomen in the male, which offers both generic and specific characters; and he suggests two more which have not yet been properly examined in this group—namely, the size of the eyes and their distance from the posterior margin of the head-capsule,

EXPLANATION OF PLATE X.

FIG.
1. *Homœolabis maindroni* Bor.
2. *Titanolabis colossea* Dohrn.
3. *Labidurodes robustus* Dubr.
4. *Mandex peruviana* Borm.
5. *Psalis americana* Beauv.
6. *Psalis gagatina* Klug. (= *Carcinophora robusta* Scudd).
7. *Logicolabis vosseleri* Zacher.
8. *Anisolabis pagana* Burr.
9. *A. littorea* White.
10. *A. verhoeffii* Zacher.

and the bow of the post-frontal and length of the occipital sutures, to which we must add the shape of the sternal plates.

Zacher begins by dividing the *Psalidæ* into two groups, one with the virga developed, the other in which the virga is absent or aborted. This seems a very tempting arrangement, especially as the virga seems to be well developed in the American genera and absent from Old World forms. Unfortunately I am forced to the conclusion that the abortion of the virga is not only not correlated, as Zacher suggests, with brachypterism and apterism, but has no apparent connexion with geographical distribution, and is not a phylogenetic character. Not only is it developed in the Australian *Titanolabis* and its allies, but it occurs sporadically in several Indian and Ethiopian species which seem to have very close affinities with neighbouring species in which no trace of virga can be distinguished. It seems to me that in these cases it has not even the value of a generic character, yet I feel obliged to erect separate genera for those species which have a virga. The question is rendered more difficult by the fact that the virga is often difficult to discern; thus in two mounts of *E. penicillata* there is no trace of virga in one specimen, but it is quite clear in another. In old and dried specimens, too, I am often in doubt whether certain structures are a virga or mere chitin-plates. I question, for instance, the identity of the virga in *Psalis* and in *Mandex* and *Metalabis*. Zacher fails to recognize it, and yet his figure shows it in *Logicolabis*, perhaps in his "*Eulabis dentata*," and in *Anisolabis verhoeffi*. In my specimens of the latter it is quite distinct.

I draw swords, too, with Zacher with regard to his statement, "wenn nun Burr sagt '*Carcinophora* seems to coincide with *Psalis*,' so hat er darin ganz offenbar unrecht, da nur *Psalis* eine Virga besitzt." He is here simply begging the question, for he relies on his own determination of a "*Carcinophora* sp." from Brazil, in the Berlin Museum, which has no virga. Now *Carcinophora* was erected by Scudder for *C. robusta* Scudd., which is only a brachypterous form of *Psalis gagatina*, congeneric with *P. americana* Beauv., the type of *Psalis*, and, as my figures show, the genitalia of the two species agree very closely, and both have a virga. *Carcinophora* is only applicable to brachypterous specimens of *Psalis*, and the creature from Brazil described by Zacher must belong to another genus. Oddly enough, he hardly refers to the genitalia: he says the præputial sacks have no chitin-plates, and he implies the absence of the virga, but makes no mention of the parameres. He states that the virga is absent; in my specimens of "*C. robusta*" it is at least as well developed as in *Psalis americana*, but I question the identity of the structure, in both, and am inclined to regard it as a mere chitin-plate. In all other Psalids the virga is a simple delicate tube, a mere non-differentiated extension of the ejaculatory ducts.

Zacher certainly attaches an exaggerated importance to the armature of the præputial sack; the presence of various chitin-plates, denticulate pads, etc., may coincide with genera in some instances, but I am convinced that they have only specific value.

After a study of a considerable amount of material, I have come to the conclusion that the best characters are afforded by the metaparameres, which are of three main types, the long, medium, and short. The presence of elytra, whether rudimentary or not, seems to have little generic value.

The best specific characters are the shape of the pronotum, the form of the forceps, and, above all, of the ninth sternite of the male, or penultimate ventral segment, and the armature of the sides of the sixth to ninth abdominal segments in the male, and the sculpture of the abdomen.

The *Psalidæ* are rather heavily built, usually sombre-coloured earwigs, with a strong tendency to brachypterism and apterism; they are to be found under stones, logs, etc., and species are numerous in hot climates. As a rule, the area of each species is rather restricted, but two, *Anisolabis maritima* and *A. annulipes*, have become cosmopolitan.

The feature which characterizes the group is the great development of the manubrium of the male, which is seldom less than one and a half times, often three times, as long as the ninth sternite; it is narrow at the base, and dilated at the apex.*

The metaparameres have a kind of false membrane, very delicate and often difficult to see, and obscured by the præputial sacks when in erection; the blade is divided into two parts by a kind of midrib.

I take the opportunity of correcting a serious slip in my fascicule on the Dermaptera in Wytsman's "Genera Insectorum," p. 25, where in the table of genera of this group the *metasternum* is given as rounded in the *Psalidæ*, and truncate in the remaining groups: of course, for "metasternum" *mesosternum* should be read. This is true of all known genera of the *Psalidæ* except *Spondox*.

After a prolonged study of a considerable amount of material, I feel inclined to give up the task in despair; I can find no character which will allow the division of the *Psalidæ* into what appear to be natural groupings, nor to separate the New World from the Old World forms. I have drafted dozens of synoptical tables, only to destroy them afterwards in disgust; I have erected, in MS., dozens of new genera, only to reject them a few days later; and now I do not feel that I am one step nearer to finality than when I started. I am convinced that Zacher's arrangement cannot hold good; that many of his genera are founded on merely specific characters; that some of them may stand, but that others must go.

* Trans. Ent. Soc. London, 1915, p. 270, pl. xxxii.

Finally, I have settled upon a purely provisional arrangement, which seems to permit the grouping into sets of more or less allied species, which may, at least, be of assistance for the purpose of mere identification of species.

We can begin by eliminating those species in which the metasternum is not truncate posteriorly, but produced into a rounded lobe, this group containing Old World forms only; we may conveniently refer to them as the *Titanolabides*. The first genus, *Spondox* Burr (New Caledonia) has the mesosternum truncate, as in most other *Psalidæ*, but in the remaining genera, *Homœolabis* Bor. (India), *Titanolabis* Burr (Australia), and *Labidurodes* Dubr. (Papua), the mesosternum is lobed like the metasternum; all this group have a long, simple virga.

We can then conveniently separate the American group of *Psalides*, but it is hard to define them as a group; here the metaparameres are elongate, more or less dilated near the base, or short and broad, almost rectangular, always attenuate apically, usually acute; the metasternum is truncate, as in the remaining *Psalidæ*; probably a simple virga is always present, but I am unable to be positive in cases where I have only had old and dry specimens to examine. In this group we include *Heterolabis* Bor., for *H. braziliensis* Bor., a Brazilian apterous species recently described and figured by Borelli, with a prominent virga; *Psalis* Serv., *sensu stricto*, for the large fully-winged *P. americana* Beauv., *P. gagatina* Burm. (which includes the "*Carcinophora robusta*" of de Bormans, Zacher, Scudder, and other authors), for a new genus which I erect here for *Anisolabis peruviana* Bor., under the name *Mandex*, and another new genus for the smaller, fully-winged, brightly-coloured species of *Psalis*, of which *P. pulchra* Rehn is the type; *P. hænschi* Burr falls here, and perhaps *P. festiva* Burr, *P. nigra* Caud., and *P. rosenbergi* Burr. This genus I call *Spandex*. And, finally, it is necessary to make a new genus for *Eulabis saramaccensis* Zacher, since his genus *Eulabis* is to be restricted to certain Old World forms, as we shall see later. This new genus I call *Metalabis*.

We are now face to face with the problem of sorting out the numerous homogeneous species inhabiting various parts of the Old World, which have hitherto been collected together in *Anisolabis* Fieb., *Euborellia* Burr, *Gonolabis* Burr.

We must, I think, first divest ourselves of the idea that the features upon which those genera are based have any great value; *Euborellia*, with its rudimentary elytra, *Gonolabis*, with its posteriorly dilated abdomen, cannot stand as such, since, it seems to me, that these are features which are most probably due to convergence. For instance, *Mandex peruviana* Borm., from Peru, with its great size, restricted habitat, and knife-like metaparameres, is not to be ranged in the same genus with the little Oriental *Eubo-*

rellia ståli, with almost quadrate metaparameres, merely because both have the elytra reduced to small lateral flaps. Again, *Euborellia* itself, that is, in the old sense, contains two distinct groups, even if we pay attention to the reduction of the elytra only, that is, those like *E. ståli*, *E. pallipes*, etc., in which the elytra are reduced to mere lateral flaps soldered to the mesonotum, and the other group, *E. greeni*, etc., in which the elytra are decidedly reduced, but still meet along the suture, and conceal the whole, or almost the whole, of the mesonotum. In the same way, the apical dilation of the abdomen, the original characteristic of *Gonolabis*, occurs simultaneously in African, Asiatic, and Australian forms, which are not necessarily closely related, and have totally different parameres.

But yet, if we were to erect new genera for all the minor groups, arranged according to the shape of the parameres, we should end by having nearly as many genera as species, and it is necessary to choose the middle course. We can begin by dividing them into two main groups. The first has the metaparameres nearly or quite as long as the proparameres, more or less lanceolate, widest in the middle, and acuminate, three or four times as long as broad. We can at once eliminate *Mandex peruviana*, of which mention has been made already, with its unusually long and powerful metaparameres; then we eliminate *Anisolabis* Fieb., as restricted, with no virga. There remain in the group the Ethiopian *Logicolabis* Zacher, with long, fine virga, and armoured præputial sack; the Ethiopian *Anisolabis pagana* Burr, with unarmed præputial sack; and two Australo-Papuan species, *A. littorea* White (New Zealand), and the diminutive *A. verhoeffi* Zacher (New Guinea), both of which differ from *Anisolabis sensu stricto* in the presence of the virga. Perhaps each of the last three species will require its own genus!

We next come to the second major group, in which the metaparameres are decidedly shorter than the proparameres, and this group is subdivided in turn into one sub-group, in which the metaparameres are from one-and-a-half to three times as long as broad, and another where they are scarcely longer than broad. Both the divisions are subdivided again and again into a number of small groupings, which at one time I thought might be genera, but I shrink from the responsibility of creating so many new genera, and leave the synoptical table as drawn, and append some cross-groupings, which will, I hope, be of assistance as help-notes for purposes of determination, which is a difficult task, owing to the general similarity of appearance of so many members of the *Psalidæ*. Help-notes, not necessarily in a very scientific form, are often of greater use than carefully drawn dichotomic tables for purposes of identification.

With the object of making this paper more useful, I have

added the descriptions of one or two novelties, together with drawings of details of several species which have not hitherto been figured.

The slender build of the Hawaiian *A. perkinsi* Burr is easily recognized.

A certain number of Old World forms have the abdomen dilated towards the apex, so that the broadest part is the posterior margin of the tenth tergite; all these were previously ranged in the genus *Gonolabis*; to-day this genus is much restricted. Two species have been removed to *Eulabis* Zacher; these are the rare Javanese, *E. kirbyi* Burr, of which only two specimens are known, and the other the large and powerful *E. michaelseni* Burr from Western Australia; in both these the dilation is effected abruptly, so that the sides of the abdomen appear to be concave when viewed from above.

The single African species, *G. picea*, is removed to *Apolabis* on account of the form of the genitalia; the remainder are divided, according to the shape of the metaparameres, into *Mongolabis*, containing the three Australian species, and *Gonolabis* proper, with only Oriental species.

In *Gonolabis* proper the synonymy is rather confused; it is worth while, perhaps, repeating that *G. kükenthali* Zacher is the second known specimen of *G. javana* Borm., well characterized by the keel on the under surface of the ninth sternite of the male. *G. electa* Burr, from the Malay Archipelago and Ceylon, may be known by its small size and the proportionately very great dilation of the abdomen; *Mongolabis pacifica* Erichs., from Australia, by the dull, deep, pitch-black colour; *M. brunneri* Dohrn, of which *Gonolabis verhoeffi* Burr is a synonym, by the tooth on the top of the forceps.

The common Malayan, *G. oblita*, with a gradually dilated abdomen, is often mistaken for *G. javana* in collections, and was probably confused by Zacher, unless his *G. sumatrana* is really *G. oblita*; the true *G. sumatrana* is a relatively much larger insect, and of a deep chestnut-brown colour rather than black.

Certain species can be eliminated without difficulty, thanks to some well-marked character; such are *Anisolabella braueri* Zacher, from North-East Africa, in which the segments of the antennæ are extremely short and knotted; also *Anisolabis maxima* Brullé, which only occurs in the Canary Islands, and can be recognized by its length, the long forceps, and the tubercles on the tenth tergite of the male; also *A. owenii* Burr, from Liberia, in which the ninth sternite of the male is produced to a point in the middle; *A. incisa* Borelli, from West Africa, where the ninth sternite has a prominent triangular incision at the apex.

Some species have a fairly well-marked personal appearance, the expression, so to speak, which once seen, can always be recog-

nized, either from actual specimens, or from a good figure; such are *A. felix* Burr, *A. westralica* Burr (Western Australia); *A. littorea* White (New Zealand); the very small *A. verhœffi* Zacher, from New Guinea; the rather stout little *A. hottentotta* Dohrn, from South Africa; the elegant *A. læta* Gerst, from East Africa; the rich claret-coloured and large *A. gestri* Borelli, from West Africa; the sturdy *A. kudagæ* Burr, from Ceylon. In most instances, the area of distribution is fairly limited, and this is a great help.

The shape of the ninth sternite of the male affords some very useful characters, both for classification and for determination. As a rule, it is only the apical portion, or actually the outline of the posterior margin which is described; properly the sternite should be dissected out, and the shape of the entire plate recorded and illustrated, with the manubrium adhering. The shape of the sternite in several species is illustrated in my paper on the manubrium; for monographic work it is important that this be done in every species. I am sure that the difficulty of determining species will thus be greatly facilitated; meanwhile, the following notes will be helpful. Owing to the fluctuating state of the genera, generic names are omitted from this list.

Grouping according to the form of the 9th Sternite of the Male.

ACUTE—*Owenii* Burr.

EMARGINATE—

Horvathi Burr.
Verhoeffi Zacher.
Kudagæ Burr.
Incisa Bor.
Marginalis Dohrn.

TRUNCATE—

Westralica Burr.
Occidentalis Kirby.
Littorea White.
Maritima Bon.
Tumida Bor.
Turgida Burr.
Pagana Burr.
Quærens Burr.
Dubronii Kirby.
Infelix Burr.
Rufescens Kirby.
Vosseleri Burr.
Braueri Zacher.
Felix Burr.
Woodwardi Burr.
Pacifica Erichs.
Vicina Burr.
Æthiopica Burr.
Kristenseni Burr.
Gestri Bor.
Læta Gerst.
Compressa Bor.
Tellinii Bor.
Maxima Brullé.
Annulipes Luc.
Saramaccensis Zacher.
Brunneri Dohrn.

In the males of some species, the sides of some of the abdominal segments, usually the seventh, eighth and ninth, but sometimes the sixth, and even the fifth, show a characteristic sculpture; these are often produced into an acute point, and more or less corrugated and rugulose, sometimes with a sharp and well-marked keel running down into the point. The point of the ninth segment usually corresponds with a lateral keel or crest on the tenth tergite, and then with the external keel or ridge of the forceps.

Sides of the 5th, 6th, 7th, 8th, and 9th Abdominal Segments of the Male.

ACUTE—

Westralica Burr.
Festæ Bor.
Tellinii Bor.
Mauritanica Luc.
Læta Gerst.
Compressa Bor.
Annulipes Luc.
Maxima Brullé.
Maritima Bon.
Littorea White.
Dubronii Kirby.
Infelix Burr.
Verhœffi Zacher.
Horvathi Burr.
Pervicina Burr.
Tumida Bor.
Angulifera Dohrn.
Isomorpha Bor.
Incisa Bor.
Silvestrii Bor.
Addita Burr.
Saramaccensis Zacher.
Sumatrana Borm.
Marginalis Dohrn.
Brunneri Dohrn.
Pacifica Erichs.
Owenii Burr.
Vicina Burr.
Æthiopica Burr.
Kristenseni Burr.
Hottentotta Dohrn.
Braueri Zacher.
Felix Burr.
Woodwardi Burr.

Sides of the Abdomen of the Male not Acute.

Perkinsi Burr.
Xenia Kirby.
Occidentalis Kirby.
Marginalis Dohrn.
Kudagæ Burr.
Turgida Burr.
Quærens Burr.
Pagana Burr.
Silvestrii Bor.
Infelix Burr.
Vosseleri Burr.
Gestri Bor.
Atra Bor.
Picea Bor.

The *Psalidæ* can thus be divided into two groups of very unequal proportions. The first, the *Titanolabides*, contains those genera in which the sternal plates are lobed posteriorly; these are four in number, occurring partly in the Oriental, but mainly in the Australian regions.

The remaining division contains all the other *Psalidæ*, and these, unfortunately, cannot be divided conveniently by any external feature, nor by any geographical feature. We have to

eliminate from our mind any idea that the development or reduction of the organs of flight is of taxonomic value; and secondly, that even the presence or absence of the virga, a feature to which Zacher, not unnaturally, attached great importance, has very great value. There are, indeed, cases where it seems to have only specific value, as, for instance, in the separation of *Anisolabis pagana*, *A. littorea*, and *A. verhoeffi* on the one hand, from *A. maritima*, *A. mauretanica*, and *A. kudagæ* on the other.

The best way, so far as I can at present see, to divide the rest of the *Psalidæ* is according to the length of the metaparameres; this has, at all events, the merit of convenience, and the results do not appear to be very unnatural. In the first group, the metaparameres are elongate, decidedly longer than broad, and therefore

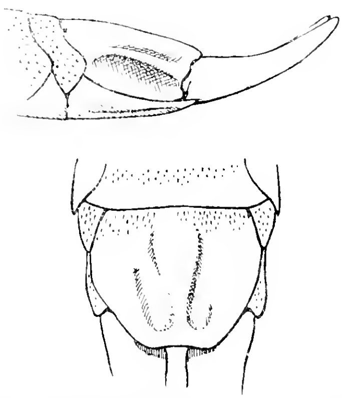


FIG. 58.—*Anisolabis isomorpha* Bor. ♂. Apex of abdomen (from a specimen from the Cameroons, in the Berlin Museum).

relatively narrow, often extremely so. In the second group, these segments are of moderate length, from one-and-a-half to three times as long as broad; and, finally, the third group, in which they are of about equal breadth and length.

I have long since come to the conclusion that the presence of chitinous pads, denticulate plates and so on, in the præputial sacks has only specific value, and that such of Zacher's genera as are based solely upon them cannot stand.

For purposes of convenience, the tables of the genera of each of these four groups is given separately.

The West African species of *Anisolabis* are rather numerous, and difficult to distinguish.

A. turgida Burr, *A. quærens* Burr, *A. pagana* Burr, and *A. silvestrii* Bor., form a group with the abdomen very nearly smooth. In *A. owenii* Burr, *A. tumida* Bor., *A. isomorpha* Bor. (fig. 58), and *A. incisa* Bor., the punctulation of the abdomen is much stronger.

The sides of the sixth to ninth abdominal segments are acute in the males in *A. tumida*, *A. turgida*, *A. isomorpha*, *A. owenii*, and *A. incisa*, and *A. silvestrii*; they are also carinulate in all these except *A. turgida*. The sides are rounded in *A. pagana* and *A. quærens*.

The ninth sternite of the male affords useful characters; it is sharply excised in *A. incisa*; it is more or less truncate, with converging borders, in *A. silvestrii*, *A. pagana*, and *A. tumida*; it is broadly rounded in *A. turgida*, and broad, with a sharp point, in *A. owenii*.

A. atra Bor. is not known to me.

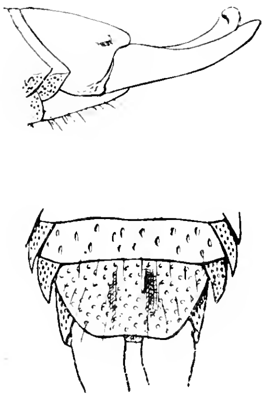


Fig. 59.—*Anisolabis angulifera* Dohrn, ♂. Apex of abdomen.

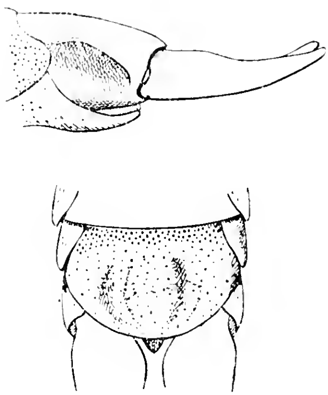


Fig. 60.—*Anisolabis quærens* Burr, ♂. Apex of abdomen (lateral and ventral view).

It is not yet certain to which form we are to refer *A. pluto* Rehn, and *A. angulifera* Dohrn (fig. 59); the former is a smooth species, and might be the female of *A. quærens* or *A. pagana*; the type seems to be a little too big for *A. tumida*.

Anisolabis quærens Burr sp. n. (Fig. 60.)

Very close to *A. turgida* Burr; differs in the absence of tubercles on the tenth tergite of the male, and in the rounded sides of the sixth to ninth segments of the abdomen of the male; the lateral keels of the tenth tergite are a little more acute.

Male.—Length of body, 11 mm.; ditto forceps, 2·25 mm.

Range.—West Africa.—Congo, Mundane, 1 male (Conradt, in Berlin Museum).

Genitalia not yet observed.

First Group.—Titanolabides.

In which the mesosternum usually, the metasternum always, are produced posteriorly into a rounded or tongue-shaped lobe.

1. Mesoternum truncate; (metaparameres elongate and parallel-sided; virga simple; apterous; New Caledonian genus) . 1. *Spondox* Burr.

1, 1. Mesoternum lobed posteriorly.

2. Metaparameres narrowed at tips; virga short; (elytra rudimentary; præputial sack unarmed; Indian genus) . . 2. *Homæolabis* Bor.

2, 2. Metaparameres parallel-sided, evenly rounded at tips; virga long.

3. Metaparameres much shorter than proparameres, gently arcuate, emarginate at tips; apterous, præputial sack unarmed; Australian genus) . . . 3. *Titanolabis* Burr.

3, 3. Metaparameres about as long as proparameres, straight, entire at tips; (præputial sack with chitin-plates; fully winged; Papuan genus) . . . . . . 4. *Labidurodes* Dubr.

Genus *Spondox* Burr.

Corpus apterum; mesosternum postice truncatum, metasternum lobatum; metaparameres angusti recti, apice rotundati, æque longi quam proparameres; virga longa, subrecta.

Totally apterous; mesosternum posteriorly truncate; metasternum lobed; metaparameres about as long as proparameres, straight, narrow, rounded at the tip; præputial sack with chitin-plates; virga long, almost straight.

For the single species, *S. sarasini* Burr, from New Caledonia.

Allied to *Titanolabis*, but differs in the truncate mesonotum, and form of the genitalia, as shown in the table.

Genus *Homæolabis* Borelli.

This genus was separated from *Euborellia* by the lobed meso- and metasternal plates, thus approaching *Titanolabis*; in general appearance, stout and contiguous forceps, it is also allied. The form of the genitalia confirms the view of its relationship. The

metaparameres are nearly as long as the proparameres, long, rather narrower at the apex than at the base, and rounded at the tip. I can detect a portion of the virga looped near the base of the præputial sack.

It contains only the Indian *H. maindroni* Bor. (Pl. X, fig. 1).

Genus *Titanolabis* Burr.

This genus is well characterized by the metaparameres, which are shorter than the proparameres, gently curved, and rounded at the apex, with a slight dilation on the inner margin near the apex. The virga is very long, and simple.

It contains only the gigantic Australian, *T. colossea* Dohrn (Pl. X, fig. 2).

Genus *Labidurodes* Dubr.

This genus remained unknown since the original description of Dubrony in 1879 until quite recently. It is practically a fully-winged *Titanolabis* with lobed meso- and meta-sterna. The genitalia agree; the metaparameres are as long as the proparameres, narrow, and rounded at the apex. The præputial sack has chitin-plates near the apex, and the virga is long, looped at the base and coiled at the apex.

The only known species is the Papuan *L. robustus* Dubr. The so-called *Labidurodes* of Shiraki certainly do not fall here; probably most of them are Eudermaptera, and the two or three species described some years ago by myself urgently need re-examination; probably they have no relation at all with *L. robustus* (Pl. X, fig. 3).

Second Group.—Psalides.

In which the metaparameres are from three to four times as long as broad.

This group at first sight does not seem to be a very natural one; but *Mandex* is only a *Psalis* with the elytra strongly recued to mere lateral flaps, that is, externally, for the parameres are of a very distinctive form. *Anisolabis* differs little from *Psalis* in the genitalia, and externally is only an apterous *Psalis*, as I have previously maintained; *Logicolabis* is a slightly modified *Anisolabis*.

I feel constrained to accept the reduction of the virga here to be only of sub-generic rank.

1. Metaparameres narrow at base, broadest in the middle, acuminate at the tips; (elytra rudimentary; Neotropical genus) . .	1. *Mandex* g.n.
1, 1. Metaparameres approximately parallel-sided, not acuminate.	
2. Virga indurated; (winged or brachypterous; Neotropical genus) . .	2. *Psalis* Serv.
2, 2. Virga not indurated, or absent.	
3. Pygidium fused with tenth tergite; (apterous; Ethiopian genus) .	3. *Logicolabis* Zacher.
3, 3. Pygidium not fused with tenth tergite; (apterous; Palæotropical genus) . . . , . .	4. *Anisolabis* Fieb.

Genus *Mandex* g. n.

Corpus apterum; elytra rudimentaria; metaparameres triplo longiores quam latiores, sensim acuminati, basi dilatati.

Apterous; elytra present as lateral flaps; metaparameres more than three times long as broad and acuminate, broad at base, gradually narrowing towards the apex; præputial sack armed with teeth and chitin-plates.

This genus is formed for *Euborellia peruviana* Borm.

Unfortunately, I have only old and dry material, but the virga seems to be short, straight and rather broad; the præputial sack has a strong chitinized armature, the details of which are obscure. The metaparameres are long, broad at the base, and regularly tapering to an acute point.

M. peruvianus Borm., from Peru, is the only known species (Pl. X, fig. 4).

Genus *Psalis* Serv.

Zacher had very little material to work upon; he states that in *P. americana* the virga is gently sinuate and longer than the metaparameres, which are acuminate. My figure shows that they are rather blunt at the tip; what is apparently the virga of Zacher is distinctly seen in my figure. I am inclined to think it is a mere chitin-plate. A similar structure is seen in the allied "*Carcinophora robusta*" (= *Psalis gagatina*), where the metaparameres are rather more pointed, and a little broader.

The smaller Neotropical species are probably all to be removed to *Spandex*, and the Palæotropical species fall into new genera (Pl. X, figs. 5 and 6).

Genus *Logicolabis* Zacher.

In *Logicolabis* I am unable to detect the "*S-förmige Verdickungsplatte*," described and figured by Zacher. As in his figure, both my specimens are in erection, and in the extruded præputial

sack of one there is a distinct tube ending in a spiral, which for me is nothing more or less than a virga; my second specimen is too darkly stained to show much detail, but there protrudes from the end of the præputial sack the long, slender apex of the same tube, and I can just detect a loop, which must be part of the same thing. Indeed, Zacher himself figures a long protruding thread, which can but be the same part.

The genitalia show a remarkable resemblance to those of *Labidurodes*, but the structure of the sternal plates is different.

We may leave this genus as good, at least for the present (Pl. X, fig. 7).

Genus *Anisolabis* Fieber.

This unwieldy genus must be restricted to those species which most nearly approach the type *A. maritima* Bon. My chief difficulty in doing this is that I can see a distinct virga in several species which are otherwise very close to *A. maritima*, and this seems a very important feature. Zacher, indeed, employed it to divide the *Psalidæ* into two main groups, those with, and those without, a virga, but this cannot hold good; he makes no mention of any virga in *A. verhoeffi*, which he figures and describes himself, yet I found the virga quite distinct in some of his original specimens, to which I had access. This suggests that the virga is in an unstable condition in this group, and may possibly be present in some individuals and absent in others of the same species.

I use the presence of the virga to subdivide the now restricted genus into two groups, as I do not want to make new genera unless I feel obliged. The chief feature of *Anisolabis*, as restricted, is the elongate, almost parallel-sided, apically rounded metaparameres. All members are totally apterous, and inhabitants of the Old World.

The few species which I retain in the genus can be easily distinguished as follows:—

1. Virga present.	
2. Metaparameres decidedly narrowed at the tips (New Zealand species)	1. *Littorea* White.
2, 2. Metaparameres not narrowed at the tips.	
3. Metaparameres very narrow, straight; very small; (Papuan species) .	2. *Verhoeffi* Zacher.
3, 3. Metaparameres gently sinuate, not very narrow; medium-sized; (West African species)	3. *Pagana* sp. n.
1, 1. Virga absent; (metaparameres not narrowed at tips)	4. *Maritima* Bon. 5. *Mauritanica* Luc. 6. *Kudagæ* Burr.

The last three can be separated by external characters, as indicated in other works. The metaparameres are straight, very gently widened about the middle, and gently narrowed at the tips, in

A. maritima and *A. mauritanica*; in *A. kudagæ* they are gently sinuate, as they are also in *A. pagana*. They are notably straight and narrow in my specimens of *A. verhoeffi*, but this is not clearly shown in Zacher's figure; my specimens were from the same tube and locality as Zacher's type (Pl. X, figs. 9 and 10, and Pl. XI, figs. 1 and 2).

Anisolabis pagana sp. n.

Allied to *A. turgida* Burr and *A. quærens* Burr; differs from the former in the rounded sides of the sixth to ninth segments of the abdomen of the male; from both in the more strongly punctu-

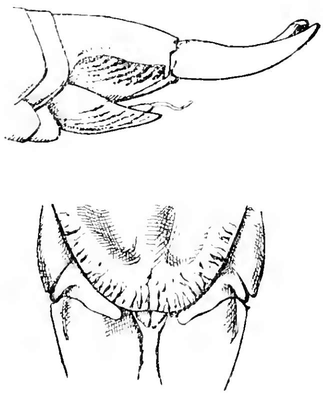


Fig. 61.—*Anisolabis pagana* Burr, ♂ type. Apex of abdomen.

late, and narrowed ninth sternite of the male, with truncate apex; in common with both, the segments of the abdomen are almost smooth

Male.—Length of body, 10·5 mm.; ditto forceps, 2·75 mm.

Range.—West Africa: Cameroon, two males (in Berlin Museum) (Pl. X, fig. 8).

Third Group.

In which the metaparameres are of intermediate length. This group is a difficult one, as it is almost impossible to resist the temptation to make too many genera; for a second time, I am obliged to treat the presence of the virga as of mere subgeneric or specific character, and in two instances at least we have apparently dimorphism in the shape of the metaparameres.

The first few genera have the metaparameres acuminate, whereas in the remainder they are blunt, or rounded at the tips, or merely narrowed, sometimes to a blunt point, but not acuminate; sometimes they are of about equal breadth almost to the ends, and then

terminate rather abruptly in a small point, or snout. The arrangement is not very satisfactory; in *Gonolabis* we have an approach to the form of *Mongolabis*, in which also the same form of the abdomen appears.

It will be noticed that I place in one genus the full-winged "*Psalis*" *dohrni*, the apterous *A. owenii* and *pervicina*, and the *E. greeni*, with much reduced rudimentary elytra.

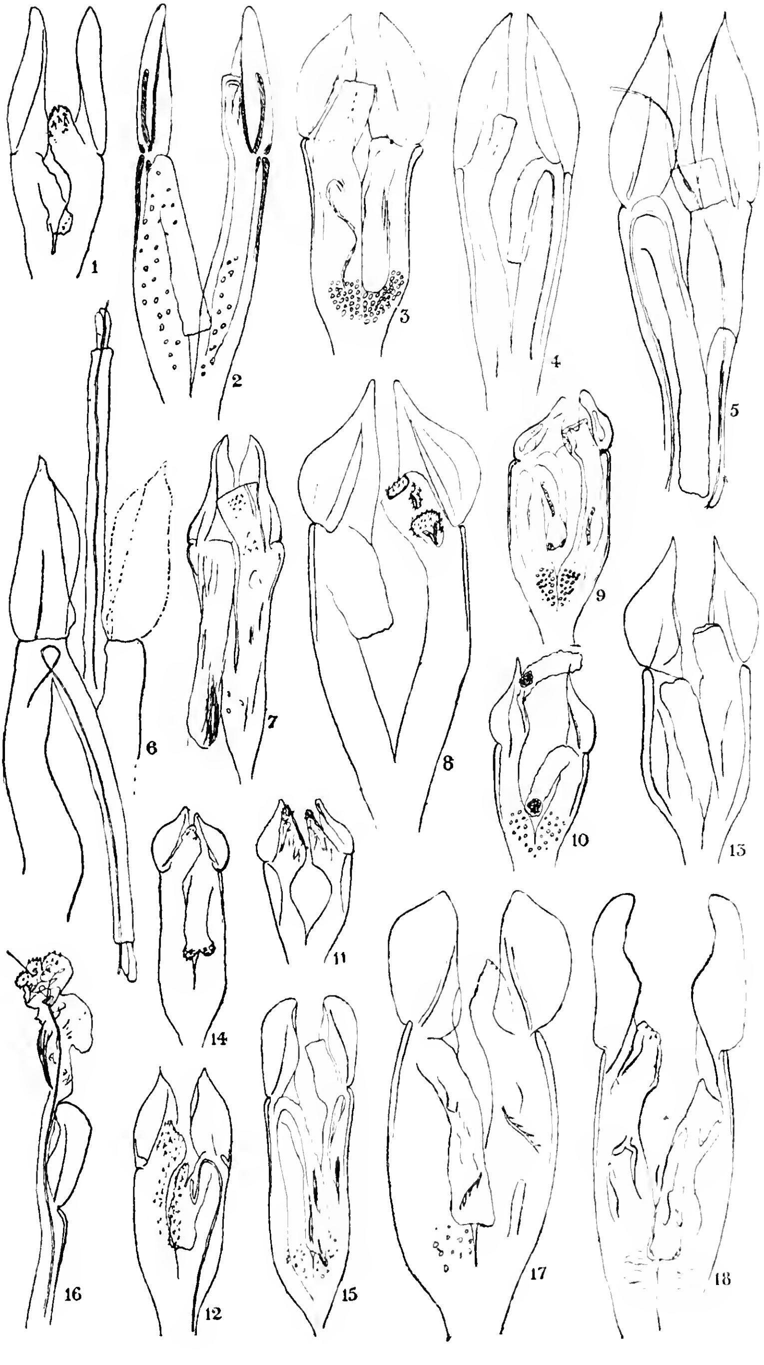
The following arrangement is suggested:—

1. Metaparameres acuminate.
   2. Metaparameres broadest in middle.
      3. Abdomen ♂ strongly dilated posteriorly; (apterous; Oriental and Australian genus) . . . 1. *Eulabis* Zacher.
      3, 3. Abdomen not strongly dilated posteriorly; (fully winged or brachypterous; Neotropical genus) . 2. *Spandex* g. n.
   2, 2. Metaparameres broadest at the base or quite near it; (apterous genera).
      3. Metaparameres broadest at the base itself, then narrowing, externally bisinuate; (Neotropical genus) . 3. *Metalabis* g.n.
      3, 3. Metaparameres broadest just beyond the base; external margin sinuate; (Old World genus) . 4. *Apolabis* g. n.

1, 1. Metaparameres not acuminate.
   2. Metaparameres rounded at tips.
      3. Metaparameres broadly rounded at tips; (elytra rudimentary; Indian genus) . . . . . . 5. *Epilabis* g. n.
      3, 3. Metaparameres gradually narrowing to the tips, which are rounded by the convexity of the external margin; (African and Oriental genus) . . . . . . 6. *Paralabis* g. n.
   2, 2. Metaparameres ending at the tips themselves in a small point or snout; (apterous).
      3. Abdomen broadest before the apex 7. *Gelotolabis* Zacher.
      3, 3. Abdomen broadest at the apex itself; (Oriental genus) . . 8. *Gonolabis* Burr.

EXPLANATION OF PLATE XI.

FIG.
1. *Anisolabis kudagæ* Burr.
2. *A. mauritanica* Luc.
3. *Eulabis kirbyi* Burr.
4. *E. michaelseni* Burr.
5. *Spandex pulcher* Rehn.
6. *S. hænschi* Burr.
7. *Metalabis saramaccensis* Zacher.
8. *Apolabis picea* Bor.
9. *A. vicina* Burr.
10. *Apolabis hottentotta* Dohrn.
11. *A. turgida* Burr.
12. *A. isomorpha* Bor.
13. *A. læta* Gerst.
14. *A. marginalis* Dohrn.
15. *Epilabis penicillata* Bor
16. Ditto, ditto.
17. *E. sisera* Burr.
18. Ditto, ditto.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Genus *Eulabis* Zacher.

Apterum; abdomen ad apicem valde dilatatum; forcipis bracchia ♂ valde remota; metaparameres lanceolati, margine externo, convexo; virga adest.

Apterous; abdomen ♂ strongly dilated apically, the tenth segment being the widest; forceps with branches ♂ very remote at base; metaparameres lanceolate, at least four times as long as broad, gradually attenuate, external margin convex; præputial sack with no chitin-plates, and no teeth discernible; virga weak.

Type.—*Gonolabis michaelseni* Burr.

Range.—Western Australia and Java.

This is evidently what Zacher figures as *Eulabis dentata*, and refers to in the text as *Gonolabis woodwardi* var. *dentata* Burr, where *woodwardi* must be a *lapsus calami* for *michaelseni*.

The form of the metaparameres is quite distinct from that of the Neotropical *Eulabis saramaccensis*; this and the very different form of the abdomen amply justify the separation of that American species into a distinct genus.

I have been able to examine the genitalia of one of my original syntypes of *Gonolabis michaelseni*. The metaparameres are indeed acute, but not so narrow at the apex as those figured by Zacher; both margins are gently convex, and the tips pointed, but not abruptly attenuated. I can detect no chitinous plates, nor teeth (Pl. XI, fig. 4).

This genus must also include the rare Javanese *Gonolabis kirbyi* Burr; only two specimens are known, both in my collection. The metaparameres are about three times as long as broad, widest in the middle, and acuminate.

We may neglect the *nomina nuda* of Verhoeff, referred to by Zacher, namely *E. kamerunensis* and *E. polita* (Pl. XI. fig. 3).

Genus *Spandex* g. n.

Elytra et alæ perfecte explicata; metaparameres haud triplo longiores quam latiores, abrupte attenuati, apice acuminati.

Fully winged; generally resembles *Psalis*, but the metaparameres are acute at the tips, rather abruptly attenuate, and not three times as long as broad; the præputial sack is unarmed; virga gently sinuate.

This genus removes from *Psalis* proper some of the smaller species, as *P. pulchra* Rehn., which I take as type, and the very distinctive *P. hænschi* Burr. Probably also *P. rosenbergi* will fall in here, and perhaps *P. festiva* Burr and *P. nigra* Caudell (Pl. XI, figs. 5 and 6).

Genus *Metalabis* g. n.

Eulabis Zacher (1911), p. 377 (partim.).

Apterum; abdomen paullo dilatatum; forcipis bracchia ♂ subremota; metaparameres apice acuminati, $2\frac{1}{2}$ longiores quam latiores, margine externo bisinuato, interno convexo, apice ipso recurvo.

Apterous; generally resembles *Anisolabis*, but forceps ♂ subremote and feebly asymmetrical; abdomen feebly dilated, attaining maximum width at the eighth segment. Metaparameres about two and a half times as long as broad, externally bisinuate, internally concave; strongly narrowed, acute apically, the tips slightly recurved; præputial sack with chitin-plates and two rows of teeth.

Type.—*Eulabis saramaccensis* Zacher.

Range.—South America (northern portion).

This genus is formed for *E. saramaccensis*, the only described species. The metaparameres are figured by Zacher. They are really of the same type as in *Spandex*, from the same countries; and this genus in fact only differs from *Spandex* in the entire absence of the organs of flight.

I possess this species from Dutch Guiana and Trinidad. In one specimen, an old and dry one, I can detect the ejaculatory duct at the entrance into the præputial sack, and on the other side, a very faint remnant of the virga at the apex of the sack. Very probably in fresh specimens the virga will be more easily discernible. (Pl. XI, fig. 7).

Genus *Apolabis* g. n.

Apterum; abdomen modice dilatatum; forcipis bracchia ♂ subremota; metaparameres modice longi, prope basin latiora, tum attenuati, apice acuti, margine externo sinuato, interno sæpius recto, apice haud recurvi.

Apterous; abdomen moderately dilated; branches of the forceps ♂ remote or subremote; metaparameres moderately long, widest near the base, but not at the base itself, then narrowed, the points acute, external margin sinuate, internal margin straight, the tips not recurved.

Type.—*Apolabis hottentotta* Dohrn.

This genus contains mostly Ethiopian forms, but I feel obliged to range here the Asiatic *A. marginalis*. The virga is visible in the West African *A. isomorpha* Bor., but not in the other species; the metaparameres in this species, too, are somewhat different,

being more gradually narrowed towards the tip. On these grounds, a new genus might be made for its reception, but I prefer to avoid erecting new genera unless compelled.

The præputial sacks have densely denticulate pads in several species, e.g. *A. isomorpha*, *A. hottentotta*, *A. vicina* Burr, *A. turgida* Burr, and *A. marginalis* Dohrn. They appear to be unarmed in *A. læta* Gerst.

Another species which I range here with some doubt is *A. picea* Bor. This species has the abdomen rather strongly dilated posteriorly, which led Borelli to place it in the old genus *Gonolabis*; I am glad, however, to remove it here, as its place seems more natural in a mainly Ethiopian genus, and *Gonolabis* can then be retained for Oriental species (Pl. XI, figs. 8–14).

Genus *Epilabis* g. n.

Elytra rudimentaria, ad suturum attingentia; abdomen pone medium dilatatum; sternum typicum; metaparameres sat longi, haud angustati, margine externo recto, interno undulato, apice late rotundati.

Elytra rudimentary, but meeting at the suture; abdomen moderately dilated just beyond the middle; sternum typical; metaparameres rather broad, but not narrowed towards the tips, the outer margin straight, the inner margin undulate, the tips broadly rounded; præputial sacks with small chitinous indurations; a fine virga sometimes discernible; forceps subremote.

Type.—*Epilabis penicillata* Bor.

Range.—Southern India and Ceylon.

This genus removes from the old *Euborellia* two South Indian species, *E. penicillata* Bor., which is characterized by a small tuft of bristles at the apex of the ninth sternite of the male, and *E. sisera* * Burr, which is characterized by a remarkable deep cavity in the middle of the head capsule; the latter species is much larger and more powerful than the former.

I am faced with a peculiar difficulty in this case. I have only seen two specimens of *E. sisera*, taken together in the Anamalai Mountains by Mr. T. B. Fletcher, who kindly sent them to me. Externally the two individuals are indistinguishable, but the metaparameres are not alike; in one, they closely resemble those of *E. penicillata*, of which I have several mounts. The other specimen, however, rather recalls the type seen in *Gelotolabis*; the figure shows the difference of outline; the convexity of the inner margin, which is so striking a feature of the type form, is

* Judges, iv. 21. My regretted friend, the late R. Shelford, suggests this very appropriate name.

not marked. Possibly this dimorphic form is a throw-back to a more primitive type; but it will be very interesting to find out which is the dominant form (Pl. XI, figs. 15–18).

Genus *Paralabis* g. n.

Genus alatum, brachypterum, vel apterum; metaparameres medio modice dilatati, apicem versus sensim angustati, apice ipso anguste rotundati; præputialis sæpius denticulata.

Fully-winged, brachypterous, with rudimentary elytra, or apterous; metaparameres moderately dilated about the middle, gradually narrowed towards the tips, which are narrowly rounded, the external margin regularly convex; præputial sacks usually with denticulate pads; no virga discernible.

Type.—Paralabis owenii Burr.

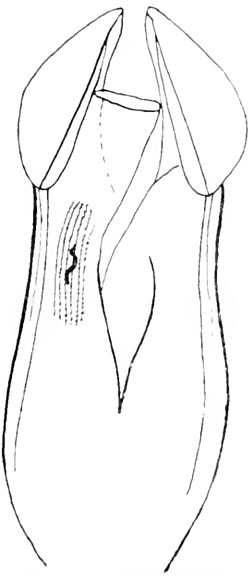
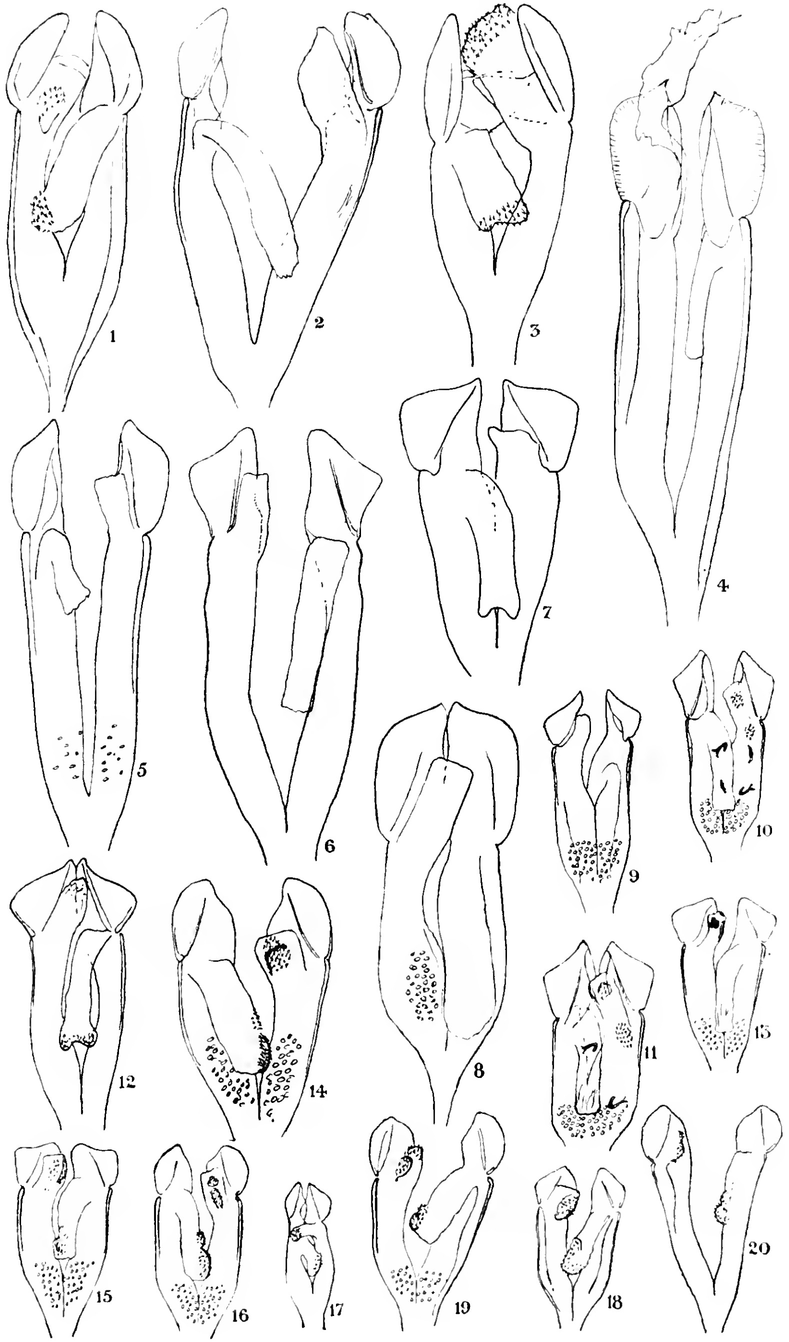


Fig. 62.—*Paralabis owenii* Burr, ♂. Genitalia.

This genus contains a number of heterogeneous species from different districts, which have a common form of metaparamere as described. These are *P. owenii* Burr, from Liberia, an apterous species, well characterized by the point of the ninth sternite of the male; *P. pervicina* Burr, an apterous species from Assam, which superficially resembles *Euborellia annulipes* Luc., but is a little larger and brighter in colouring; *P. greeni* Burr, from Ceylon and Southern India, in which the elytra are rudimentary, but meet along the suture; and *P. dohrni* Kirby, a fully-winged Indian and Singalese species, with a superficial resemblance to *Labidura*; it is characterized by a submetallic deep blue sheen. *P. owenii* has a well-marked

EXPLANATION OF PLATE XII.

FIG.		FIG.	
1.	*Paralabis dohrni* Kirby.	11.	*Mongolabis brunneri* Dohrn.
2.	*P. greeni* Burr (black form).	12.	*Mongolabis* (?) sp. (Formosa).
3.	*P. pervicina* Burr.	13.	*Euborellia janeirensis* Dohrn.
4.	*Gelotolabis æthiopica* Burr.	14.	*E. insulana* Bor.
5.	*G. infelix* Burr.	15.	*E. cincticollis* Gerst.
6.	*G. maxima* Brullé.	16.	*E. debilis* Burr.
7.	*Gonolabis oblita* Burr.	17.	*E. tellinii* Bor.
8	*G. electa* Burr.	18.	*E. compressa* Bor.
9.	*Mongolabis woodwardi* Burr.	19.	*E. mœsta* Géné.
10.	*M. pacifica* Erichs.	20.	*E. andreinii* Bor.



[Face p. 540.

pad of denticulate striæ in the præputial sack; in *P. dohrni* and *P. perricina* there is a strongly marked denticulate pad at the end of the sacks, but I cannot detect any teeth in *P. greeni*. The specimen of *P. greeni* from which I drew the mount was one of the large black race from Ceylon referred to in my Dermaptera of British India. I have an idea that when we examine the genital armature of the typical form, we shall find it of the *Epilabis* type, with which group typical *P. greeni* agrees externally very closely (Pl. XII, figs. 1–3).

Genus *Gelotolabis* Zacher.

I prefer to expand the genus *Gelotolabis* of Zacher, to neglect the absence of "Chitinverdickungen" in the præputial sack as a generic character, and to define it by the shape of the metaparameres, which are about equally broad through their length, but terminate in a small tip or snout; the outer margin is gently convex as a rule, but in *G. maxima* Brullé the convexity is more pronounced, assuming the form of an obtuse angle, which at first inclined me to make a separate genus for it. I sink here Zacher's genus *Horridolabis*, as being insufficiently characterized. His type species, *H. paradoxura*, is identical with my *Anisolabis felix*. The type of *Gelotolabis* is *G. burri* Zacher, in which I sink *G. æthiopica* Burr; other species are the allied *G. kristenseni* Burr, also from Abyssinia, and *G. infelix* Burr, from Central Africa. Thus, at present it contains only African species, and, when *G. maxima* is removed, only purely Ethiopian species (Pl. XII, figs. 4–6).

Genus *Gonolabis* Burr.

This genus is now very much reduced, only containing a few totally apterous Indo-Malayan species, in which the metaparameres, a little longer than broad, are rounded externally, and the abdomen in the male attains its greatest breadth at the tenth sclerite.

Zacher differentiates it from *Euborellia* only by the absence of teeth in the præputial sack, and the absence of any trace of rudimentary elytra, but the form of the metaparameres more closely resembles that of *Gelotolabis*; it differs from that genus in the usually smaller size of the species, in their occurrence in the Indo-Malayan province, and in the marked apical dilation of the abdomen in the male.

Zacher's *G. kükenthali* is identical with *G. javana* Bor.; I have compared the two types, and there is no doubt whatever as to their identity. *G. javana* is sharply characterized by the rather peculiar coloration, and by the keel on the ninth sternite of the

male. What has long passed for *G. javana* in collections is *oblita* Burr, which is probably what Zacher refers to under the name of *G. javana*, and perhaps also *G. electa* Burr, known from Java and Ceylon. The genitalia of the latter are figured, and it will be observed that they agree well with those of *G. javana* as figured by Zacher. Probably Zacher's identification of *G. sumatrana* is correct, as this is far less rare than *G. javana*, and has not been subject to the same confusion and mistaken identity.

If Zacher had given the dimensions, there would be no doubt in the matter, as *G. sumatrana* is a much larger creature than *G. oblita*. Zacher quotes Buitenzorg for his *G. javana*, a well-known locality for *G. oblita*, just as Fort de Kock in Sumatra is for *G. sumatrana*. His figure of *G. sumatrana* are like those of *G. oblita*; those of the authentic *G. sumatrana* are unknown.

On the assumption that under the name of *G. javana* Zacher is referring to *G. oblita*, we have only the following species now in *Gonolabis*:—

G. javana Bor., Type (= *G. kükenthali* Zacher).
G. sumatrana Bor.
G. oblita Burr (= *G. javana*, auctt. nec Bor.).
(Pl. XII, figs. 7 and 8.)

Fourth Group.

Metaparameres as broad as long, or broader than long.

This group contains a number of forms from all regions, but mainly palæotropical, more or less closely resembling each other superficially, all of rather small size, showing every stage of wing-development.

We can eliminate first the Neotropical *Heterolabis* Bor., with a well-developed virga, and *Anisolabella* Zacher, from North-Eastern Africa, with spindle-shaped antennal segments.

The remaining forms fall into two groups: those with the meta-parameres externally rectangular, and those with them rounded on the outer margin. Easily separated first is *Mongolabis* Zacher, which contains a number of what were formerly ranged in *Gonolabis* —totally apterous forms, with the male abdomen dilated towards the apex; this genus contains only Oriental and Australian forms.

The remainder, with non-dilated abdomens, might be allotted to two genera, according to the outline of the metaparameres; but I prefer to regard this, provisionally at least, as a subgeneric character, and put the whole of the remainder into *Euborellia* Burr, modified by the exclusion of *E. sisera*, *E. greeni*, *E. penicillata*, etc., and by the inclusion of the apterous *E. annulipes* Luc., *E. incisa* Bor., *E. compressa* Bor., and the fully-winged *E. janeirensis* Dohrn.

and *E. cincticollis* Gerst. It should be noted, however, that *E. janeirensis* shows every gradation from perfect wing-development, or at least perfect elytra, to brachypterism, and possibly total apterousness; apparently the same elasticity occurs in *E. cincticollis.*

This group may therefore be tabulated as follows:—

1. Antennal segments spindle-shaped; (no virga; metaparameres broadly triangular; apterous; Ethiopian) . 1. *Anisolabella* Zacher.

1, 1. Antennal segments cylindrical.

- 2. Virga well-developed; (apterous; Neotropical genus) . . . . . 2. *Heterolabis* Bor.

- 2, 2. Virga not developed.

  - 3. Abdomen ♂ dilated at the apex; (apterous; Oriental and Australian genus; metaparameres externally rectangular) . . 3. *Mongolabis* Zacher.

  - 3, 3. Abdomen not dilated apically; (fully-winged, with elytra rudimentary, or apterous) . . 4. *Euborellia* Burr.

Genus *Anisolabella* Zacher.

This genus is well characterized. It is the only known Psalid in which the antennæ have the segments spindle-shaped. The metaparameres are very broad, in the form approximately of an almost equilateral triangle, with curvilinear, gently convex sides, and rounded angles.

It contains a single species, *A. braueri* Zacher, from North-Eastern Africa. The genitalia are figured by Zacher.

Genus *Heterolabis* Bor.

Differs from *Psalis* in the subrectangular metaparameres. Contains the single species *H. brasiliensis* Bor.

Genus *Mongolabis* Zacher.

In his arrangement of the *Psalidæ*, Zacher separates the genera *Gelotolabis* and *Mongolabis* from each other by the absence and presence of teeth in the præputial sack, and by trifling differences in the form of the parameres, and both are separated from *Euborellia* and *Gonolabis* by the absence of "Chitinverdickungen" in the præputial sack. If we carry Zacher's system to

its logical conclusion, we shall be compelled to erect a disproportionately large number of genera, each with very few species. Zacher's type of *Mongolabis* is *M. woodwardi* Burr, from Western Australia. Closely akin are two other Australian species, *M. pacifica* Erichs. and *M. brunneri* Dohrn, agreeing in the external structure as well as geographical distribution; but the two latter have structures in the præputial sack which, according to Zacher, would at once remove them from *Mongolabis*, and justify a new genus. The præputial sacks also have series of minute teeth, but not confined to the pads of chitin, as in *Euborellia*. It is therefore necessary to modify the original definition of *Mongolabis*, so as to comprise the three Australian species, *M. woodwardi* Burr, *M. pacifica* Erichs., and *M. brunneri* Dohrn. They are simply *Gonolabis*, with short, broad, and nearly triangular metaparameres (Pl. XII, figs. 9–12).

Genus *Euborellia* Burr.

This genus is very much altered. It was originally erected for those species of *Anisolabis* (in the old sense) in which the elytra were present as rudiments. Zacher rightly questions the validity of this feature as a generic character, and points to its extreme instability of the elytra in *E. janeirensis*; he also records an anelytrate variety or aberration of *E. mœsta* Géné, the type species, but here I am inclined to doubt the identification. Recently Father Pantel appears to have discovered a remarkable fully-winged aberration of *E. annulipes*. *Euborellia* will now contain totally apterous and also fully-winged species. It is now to be defined by the short, broad metaparameres, which are sometimes broader than long; strongly denticulate pads are usually present in the præputial sacks. The metaparameres are sometimes right-angled externally, and sometimes rounded; perhaps this feature may be regarded as a generic character.

The species which are now included in *Euborellia* as now defined are the following:—

1. Metaparameres externally rectangular.
    2. Elytra free, perfect or abbreviated; wings perfect or abbreviated:—
        1. *E. janeirensis* Dohrn. (S. America).
        2. *E. cincticollis* Gerst (W. Africa).
    2, 2. Totally apterous:—
        3. *E. compressa* Bor. (E. Africa).

1, 1. Metaparameres externally rounded.
    2, 2. Fully-winged (normally):—
        4. *E. debilis* Burr (E. Africa).
        5. *E. insulana* Bor. (Seychelles).

2, 2. Elytra reduced to lateral flaps on the sides of the mesonotum:—

6. *E. mœsta* Géné. (S. Europe).
7. *E. andreinii* Bor. (N.E. Africa).
8. *E. ståli* Dohrn. (India).
9. *E. feæ* Bor. (E. Africa).

2, 2, 2. Totally apterous (normally):—

10. *E. annulipes* Luc. (Palæarctic and cosmopolitan).
11. *E. tellinii* Bor. (E. Africa).
12. *E. incisa* Bor. (W. Africa).

And perhaps we may add *E. pallipes* Shir., from Formosa, which very closely resembles *E. ståli* in external characters; possibly

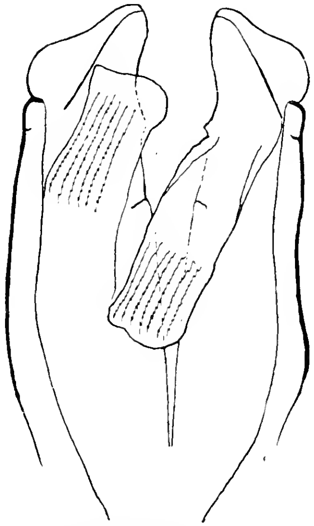


FIG. 63.—*Euborellia incisa* Bor., ♂. Genitalia.

also the Neotropical *E. nigra* Caud., which I am inclined to think was a stray specimen of *E. ståli*.

The instability of the organs of flight is well illustrated by *E. janeirensis*, in which we find specimens with almost every degree of development and reduction, and from material available I think we shall find the same thing in the West African *E. cincticollis* Gerst.

It is difficult to express clearly the difference between *E. annulipes*, *E. compressa*, and *E. tellinii*, but once authentic specimens have been compared and the difference in appearance recognized, they can hardly be confused. *E. incisa* Bor. can be recognized, as the name implies, by the triangular incision in the apex of the ninth sternite of the male (fig. 63, and Pl. XII, figs. 13–20).

A Puzzle.

The accompanying figure (fig. 64) shows a remarkable form of genital armature, which I am quite unable to determine; the mount

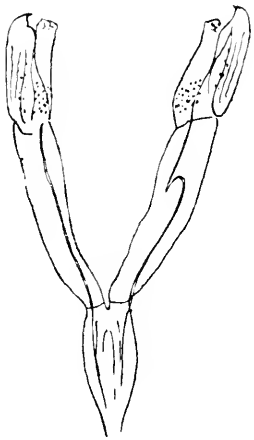


Fig. 64.—A Puzzle.

is labelled "*Anisolabis tellinii* Bor.," but this must be an error, for it is of a totally different type from the five or six preparations of that species which I have examined, and indeed, is not a Psalid type at all. By no process of elimination can I discover from which specimen it was taken. It will be interesting to discover eventually from what species it was drawn, for I can hardly imagine that it is an aberrant apparatus from a real *A. tellinii*.

IX.—*A short Statement upon the Theory, and the Phenomena of Purpose and Intelligence exhibited by the Protozoa, as illustrated by Selection and Behaviour in the Foraminifera.**

By Edward Heron-Allen, F.L.S., F.Z.S., F.R.M.S.

(*Read October* 20, 1915.)

> "Unless we set out with the preconception that mind is the prerogative of man, the question whether mind is co-extensive with living protoplasm, or is the possession of only the more highly organized animals must at some time suggest itself. But whatever prejudices we may hold, it is incumbent upon us before definitely accepting either view, to ascertain if possible the level at which the first manifestations of mind occur."
>
> *E. M. Smith, Op. cit. post. p.* 1.

In the month of November 1914 I showed, in conjunction with Arthur Earland, at a meeting of the Zoological Society a series of slides of Foraminifera, exhibiting phenomena of life-habit and shell-construction which, in my opinion, revealed the possession by these organisms of faculties akin to Purpose and Intelligence.† A discussion ensued, in the course of which certain eminent zoologists combated, and certain others no less eminent supported my views. Since that date the matter has been referred to, explicitly and otherwise, in several articles and reviews and more than one treatise, having for their subjects, "Mind" and "Behaviour" in the lower animals, and some of the writers have sought to give to my words a far more extended meaning than that which I intended to convey, regard being had to the present state of knowledge and observation upon the subject. I have also been favoured with a considerable amount of correspondence on the subject by prominent zoologists and biologists. I therefore sought the opportunity afforded by the meeting of the British Association at Manchester to summarize my published observations upon the matter, and to establish clearly the position beyond which for the present I do not wish to go.‡

* The principal portion of this paper formed the basis of an address which was read before the British Association (Section D, Zoology) at Manchester, Sept. 9, 1915, and which was followed by a discussion upon the points at issue.

† Proc. Zool. Soc. Lond., 1914, p. 1069. It must be observed at once that these words are used here in a specialized and restricted sense (see note § on p. 551).

‡ For instance, I do not wish to refer further, at present, to the mechanical functions of the Foraminiferal protoplasm, with which I have dealt at length elsewhere (Bibliography 8, pp. 231, *et seq.*).

In the years 1907–8 I made a series of gatherings of the littoral and shallow-water Foraminifera of Selsey Bill (S.W. Sussex), the description and diagnoses of which were published in a series of eight papers between 1908 and 1911.* Among these gatherings my collaborator Arthur Earland and I were immediately impressed by the occurrence of some species of arenaceous Foraminifera, a certain restricted number of individuals of which appeared to select and to incorporate among the smaller and normal grains of quartz-sand, of which their shells were constructed, relatively large fragments of coloured gems and other minerals, such as garnet, topaz, and magnetite, which gave a very striking and ornamental appearance to the tests. The incorporation of these fragments afforded food for some reflection, for the specific gravity of these fragments is very much higher than that of the normal quartz-grains—e.g. garnet having a specific gravity of 3·7–4·1, as against the 2·65 of quartz. The result of this is that the gem fragments are not normally to be found in the same layers as the quartz, but sooner or later invariably sink below it, a fact which may be demonstrated by dropping a handful of sand mixed with gem dust into a narrow observation-tank, when it will be found that after a little rocking, such as would result from wave action, the gem minerals are accumulated in a thin stratum at the bottom. The method therefore by which the organisms obtain these heavier grains—and only a restricted proportion of the specimens do so obtain them—is highly problematical.†

This tendency is observable to a marked degree in specimens

* Bibliography 1.

† Mr. Allan B. Dick, who has made a specialized study of the heavy minerals to be found in almost all sands, tells me that the minerals are to be collected separately by pressing a balsam-covered slip upon the wet surface of a sand which has been subjected to the gentle action of moving water. He suggests, not without some reason, that such action "elutriates" and carries away the lighter quartz-grains, leaving the heavier minerals *temporarily* upon the surface, and that they are thus left readily available for the constructional purposes of the organism. If this be the real explanation of the phenomenon, it would appear that when an organism (e.g. *Verneuilina polystropha*) is found to have used these heavier mineral grains, it has constructed its test in a runnel subject to such movement, whilst if it has not used them it has constructed, or enlarged its shell, in a peaceful pool not subject to such movement, or, whilst attached to algæ or stones above the sand, from the churned-up and lighter quartz-grains. My only difficulty in accepting this explanation lies in the fact that the great majority of the shells do live upon bottom-sands subject to such movement, and only an infinitesimal proportion of them are found to have incorporated such grains. *Haplophragmium agglutinans* in the living condition is, in my experience, always found upon waving algæ, or attached to the sides of rocks and stones, and practically never in shore scrapings or shallow dredgings, but it is found (*ut supra*) to display the phenomenon to a more marked degree than almost any other Foraminifera. Further, a Foraminifer is itself so much lighter than even the quartz-grains that the action of the moving water might be expected to remove it with them. (For a full account of Mr. Dick's method and observations, see "Nature," xxxvi. (1887) p. 91, and W. Whitaker, "The Geology of London, etc." Geol. Survey, 1889, p. 523.)

of *Reophax scorpiurus* Montfort, all over the world; at Selsey Bill *Verneuilina polystropha* Reuss, selects garnet and topaz, whilst there and everywhere else *Haplophragmium agglutinans* d'Orbigny shows a marked affinity for magnetite. With regard to the latter we have elsewhere noted that among the dredgings from the Kerimba Archipelago, which form the subject of our Monograph in the Transactions of the Zoological Society,* though the species was extremely rare and magnetite was only present in the sands in very small proportions at widely distant areas, the few specimens found had incorporated large and eccentric grains of this mineral in their tests.† Not to multiply instances we have noted this same selective tendency in specimens of *Reophax difflugiformis* Brady, from New Zealand. It is difficult to know what biological significance, if any, to attach to this apparently purely ornamental use of grains of building material contrasting highly with the remainder, regard being had to the lowly organization of the builder. I have been constrained to disclaim the attribution of an "æsthetic sense" to these organisms, but Professor J. Arthur Thomson, in a recent review of my paper on the subject in the Phil. Trans.,‡ speaking of the co-ordination of selected materials, observes, "When we remember that this is no matter of 'organic cristallization,' but the result of placing extraneous materials, selectively gathered, in a definite and singularly effective arrangement, we feel that we are approaching the dawn of art."§

The "intelligence," however, which, I am bold enough to claim, is displayed by the arenaceous Foraminifera in their house-building takes two forms: first, the exclusive selection of certain materials, and second, the manner in which they are used. The exclusive selection of echinoderm plates by *Technitella thompsoni* H-A. & E., for the construction of its test, is a most remarkable illustration of this selective power, for in neither of the dredgings in which it has been found do echinoderm plates such as are used in its construction abound, indeed they form an infinitesimal percentage of the material as dredged, and their presence would remain unobserved unless especially searched for.‖ Yet this microscopic organism selects and uses only these highly perforated plates, the perforations serving it as apertures for the extrusion of its pseudopodia, a specialized and definite aperture being non-existent in this species, though very pronounced in the other species of the genus. The genus *Technitella* as the name "Little

* Bibliography 6.
† Bibliography 8, p. 267; and 6, part ii. p. 613.
‡ Bibliography 8.
§ J. Arthur Thomson, "Before the Dawn of Art," *New Statesman*, October 23, 1915.
‖ Bibliography 2; and 8, p. 267.

Workman" (given to it by Canon Norman) implies,* not only exhibits the selective tendency to a very significant degree, but it also supplies us with one of the most remarkable illustrations of purpose and intelligence hitherto encountered in the Foraminifera. The most familiar species of the genus *Technitella legumen* Norman, constructing its test only of sponge-spicules selected from the mass of mud, sand, molluscan and foraminiferal debris in which it lives, builds its shell-wall in two layers, the outer one set parallel to the long axis of the shell, the inner one at right angles to it. As we observed when we first discovered this feature,† "we thus get as close an approximation to 'woof and warp' as is possible in a rigid non-flexile material, and it is obvious that the strength of the test must be enormously increased by the crossing of the two layers, as resistance to tensile strain is given in two directions instead of one."‡ In the papers to which I have already referred and in others tabulated at the end of this paper, we have called attention to the phenomena upon which I have postulated the exhibition of obvious "Purpose and Intelligence" by certain other species of Foraminifera, and the student is referred to them for minuter details from which it is shown "that there is as wide a range of skill displayed by the Foraminifera both in choice of material and in actual construction as by builders in the higher scales of life, not even excepting man."§

We see sponge-spicules in particular used in great variety of specialized and ingenious ways. 1. As building material pure and simple, the whole spicules, or fragments of spicules, being in most cases selected of exactly the length to suit the position they are to occupy in the test, e.g. *Technitella melo* Norman. 2. As "joists" to strengthen the construction of a test, e.g. *Sorosphæra confusa* Brady. 3. As "laths" in a plaster wall to retain the mud and sand-grains in position, e.g. *Haplophramium* spp. 4. As a protection against parasitic worms and prowling mollusca, e.g. *Haliphysema tumanowiczii* Bowerbank, *Crithionina pisum* var. *hispida* Brady, and many others. 5. As catamaran spars to support the animal upon the surface of soft oozes, e.g. *Psammosphæra parva*

* See A. M. Norman, "On Two New Genera perhaps allied to Haliphysema," Ann. Mag. Nat. Hist., Ser. 5, vol. i. 1878, p. 279; and "On the Architectural Achievements of Little Masons, Annelidan (?) and Rhizopodan, in the Abyss of the Atlantic," ibid. p. 284.

† Bibliography 3, p. 383; and 8, p. 267.

‡ As Professor J. Arthur Thomson has admirably described this organism in the review quoted (*supra*):—"We, speaking for ourselves, would still say (following Claparède and Lachmann, 1858), 'The animal cannot be just a mass of sarcode.' It is that, no doubt, but there is another side to the little fraction of reality which we call *Technitella*. It is a psycho-physical individuality whose experiments in self-expression include a masterly treatment of sponge-spicules, and illustrate that organic skill which came before the dawn of Art."

§ Bibliography 2, p. 408.

Flint and *P. rustica* H-A. & E.* 6. As "flying buttresses" to keep the animal aperture upwards on the mud, e.g. *Nouria harrisii* H-A. & E.† 7. As a *chevaux-de-frise* protection for the aperture only, in large apertured species, e.g. *Marsipella cylindrica* Brady. 8. Spirally, to give a rope-like resistance to fragile cylindrical species, e.g. *Marsipella spiralis* H-A. & E. Instances might be greatly multiplied, and will be found in the papers already referred to. In my opinion a specialized quality of Purpose and Intelligence are revealed by these phenomena. If they depended upon, or resulted from, surface-tension, all the individuals in a dredging would exhibit the same phenomena; whilst the suggestion that natural selection has resulted in the survival of the fittest is met by the reply that these selective and purposive individuals constitute a marked minority in the dredgings in which they are found.

It is upon protracted observations of these phenomena that I have been led to formulate the postulates which constituted the Abstract of my "Statement" at Manchester,‡ and which are as follows:

1. That every living organism living a separate and independent existence of its own is endowed with that measure and quality of the faculties of Purpose and Intelligence § which are adapted to, and called forth by the individual needs of that organism.

* The latter species, building a polyhedral test, selects fragments of spicules of graduated sizes to fill in the "panels" of its house, often ending off an awkward corner with a truncated triaxial sponge-spicule. Such a phenomenon would be of little significance if isolated, but we find it repeated in all the panels of the test, and even in rigidly associated pairs and groups which have no independent power of rolling about and gathering up only what "happens to fit" the spaces to be gradually filled.

† This animal also lays sharply-pointed curved spicules, with their points turned inwards, at its mouth, to prevent the ingress of parasites, as the inverted twigs of a lobster-pot prevent the egress of the lobster.

‡ See Report of the Meeting of the British Association, Manchester, 1915. (*In the Press.*)

§ As Haynes has accurately observed in his opusculum quoted further on, "Our human vocabulary is at present most inadequate for discussing problems of this kind." The phrase "Purpose and Intelligence" is anthropomorphic, and therefore unfortunate, but the language provides no other phrase by which the faculties to which I am calling attention can be expressed, the faculties themselves being hitherto but vaguely surmised, and not at all defined. Professor Flinders Petrie, in an as yet unpublished Essay, has suggested the word "Selector" to convey an idea of the quality of purpose and intelligence displayed by unconscious reason of all grades—its function being to select natural forces to arrive at certain results. I am not inclined at present to regard this as quite a happy phrase. It is probable, however, that some more concrete term may be found as the study of these faculties progresses. The word "Selector" seems to me to suggest a functional impersonality, which conveys an idea of something metaphysical. What we require is a term which shall express an all-pervading quality of Living Matter, however primitive it may be, from the Chlamydozoon to the Calculating Boy, which enables and causes Living Matter to do what is necessary for its protection and adaptation to environment, independently of the quality which we recognize as life. Professor Flinders Petrie allows me to quote the following from his very suggestive and significant Essay:—"The Selectors vary immeasurably. The difference between the highest and the lowest individuals of

2. That the existence of these faculties are made manifest by the utilization of foreign and extraneous materials selected by the organism from out of the vast heterogeneous mass of available and adaptable material composing its environment—and utilized in such manner as is required by the individual needs of the organism —either for the purpose of adapting itself to its special environment, or for protecting itself against its special enemies or environmental dangers.

3. That a consistent evolutionist is debarred from postulating a break in his evolutionary cycle (which must *ex hypothesi* be continuous) for the purpose of introducing from outside at some unspecified point a new influence of unknown origin to which he gives the name Intelligence, and which, it would thus seem, makes a sudden appearance as a result of new activities of the Body-cells.

4. That the Phenomena to which I have called attention have no relation to, and are not to be confounded with, Adaptations or Tropisms, and I am not to be interpreted as having made any claims based upon any such confusion.

It was not to be expected, nor, accordingly, did I expect that these postulates would pass unchallenged, and I should have regretted the fact had they been received in disrespectful silence. I take advantage of the opportunity now afforded me to make my position, if possible, clearer.

To the broad objection that none even of the Metazoa exhibit any phenomena of purpose and intelligence, the reply does not seem to me to be far to seek; it must be to a great extent a matter of observation and opinion, and of the correct use of terms—the terms "Behaviour" and "Psychology" are now being a good deal bandied back and forth across the Atlantic Ocean. The evidence in refutation of such an objection has been marshalled and presented in a most attractive form by our late President, Professor J. Arthur Thomson, in his remarkable and fascinating book, "The Wonder of Life,"* a work whose convincing and scientific accuracy is in no way impaired by the popular and interesting manner in which the facts are arranged and put forward. One of the

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men is so great that it seems hard to draw the line and deny a similar principle of Selectors determining the highly intelligent actions of such animals as beavers, dogs, apes, or elephants. If so, there is no break possible until we attribute Selectors to even the lowest forms of life, for consciousness and volition are not attributes of a Selector. The Selector in different animals is limited to the requirements of those animals. It devises and works in every way to meet the natural conditions. . . . It has no train of action ready for un-natural circumstances. It is not omniscient, but is specifically adapted." "It is useless to try," writes the author, "to realize the nature of this immaterial Selector—it is as much outside our physical conditions as electricity was outside the physical realization of man a century ago. No known laws of matter have any relation to the Selector; we can only catalogue its powers and action."

* London: Melrose, 1914.

latest protagonists has thus defined the position.* "The behaviorist attempts to get a unitary scheme of animal response. He recognizes no dividing line between man and brute. The behavior of man with all its refinement and complexity forms only a part of his total field of investigation. . . . The time seems to have come when psychology must discard all reference to consciousness; when it need no longer delude itself into thinking that it is making mental states the object of observation." This is a passage which may be considered in connexion with a much earlier observation of Huxley. He says, "It seems to me that in men as in brutes there is no proof that any state of consciousness is the cause of change in the motion of the matter of the organism. The feeling we call volition is not the cause of a voluntary act, but the symbol of that state of the brain which is the immediate cause of that act."† In another place he says: "I have endeavoured to show that no absolute structural line of demarcation . . . . can be drawn between the animal world and ourselves; and I may add the expression of my belief that the attempt to draw a psychical distinction is equally futile, and that even the highest faculties of feeling and of intellect begin to germinate in lower forms of life."‡

Dr. Chalmers Mitchell, on the other hand, lays down a contradicting dogma. He says, "Intelligence, purpose and choice are meaningless phrases unless they imply consciousness, and the sense of freedom."§ Professor J. Arthur Thomson, on the other hand, in the review from which I have already quoted (*supra*), observes—and I entirely agree with him—"Just as we have rational skill, and intelligent skill, and instinctive skill, so perhaps we have in these Foraminifera, organic skill, when the simple individuality, pulling itself together, acts as a unity and then perhaps feels itself as one. For it is not fantastic to suppose that in such critical moments of endeavour and adventure consciousness first found, and still finds, its simplest glimmering expression."

I refuse to admit that my critics have any right to make use of the anthropomorphic argument.|| The behaviour of men and of the lower or lowest animals must not — cannot be considered upon the same plane. I will not have the responsi-

* J. B. Watson, "Behavior." New York, 1914, pp. 1, 7.

† T. H. Huxley, Collected Essays, i. London, 1898, p. 240.

‡ "On the Relations of Man to the Lower Animals," ibid., vii. London, 1910, p. 152.

§ "Evolution and the War." London, 1915, p. 96. Dr. Chalmers Mitchell is criticizing in unmeasured terms the following passage from Professor Bergson's Huxley Memorial Lecture (Birmingham, 1914):—"With the coming of life we see the appearance of indetermination. A living being, no matter how simple, is a reservoir of indetermination and unforseeability, a reservoir of possible actions, in a word, of choice."

|| Cf. Watson, op. cit. p. 27. "From the viewpoint here suggested, the facts on the behaviorof amœbæ have value in and for themselves without reference to the behavior of man."

bility (not that I shrink on occasion from responsibility) thrust upon me of saying that the Purpose and Intelligence—perhaps "Purposive Intelligence" would be a better phrase—displayed by a Protozoon is in any way comparable to that displayed by a man, or by animals vertebrate or invertebrate, or even by the Crustacea, Cœlenterates, and Annelids. St. Paul was not expressing himself in terms of Zoological Science, but he was undoubtedly stating an incontrovertible fact when he said "there is one kind of flesh of man, another flesh of beasts, another of fishes and another of birds"—for "flesh" substitute "intelligence," and the purpose for which that intelligence is used, adapted especially (limited, if you will) to the peculiar needs and limitations of the organism which it endows and illuminates. What Biologist can say at what point reflex action and instinct stop and intelligence begins? What Physiologist will say that intelligence cannot be postulated in the absence of specialized nerve fibre?*

An argument propounded by one of my most esteemed and distinguished critics† was that the action of a Foraminifer in the selection of rare foreign bodies from among a vast mass of heterogeneous available material, and its manipulation of that specialized material for purposes of self-protection is not different from that of any cell of the human body in selecting from its environment the matter requisite to its functions and life-processes as part of the communal whole which makes up the body. With great respect I entirely disagree. I should deeply regret if any words of mine should be taken to convey an expression of opinion that the adaptive processes of a human body-cell display individual purpose or intelligence. Nor, *a fortiori*, would I suggest that a calcareous Foraminifer displays purpose and intelligence in secreting the carbonate of lime of which it constructs its shell,‡ or that an arenaceous Foraminifer displays purpose or intelligence in collecting sand grains or other fortuitous *but inevitable* particles for the construction of its test. But it was in no flippant spirit that I replied that if an individual body-cell were to select from its environment some foreign material to act as an umbrella to protect it from a rain which threatened its neighbours that would be to my mind evidence of purposive intelligence peculiar to that cell, and would

* A recent writer has thus stated the case entirely in agreement with my views:—"Though the activities of unicellular organisms reveal no irrefragable proof of the presence of mind, a study of their conduct suffices to exhibit at least a fundamental resemblance to so-called 'intelligent' behaviour." (E. M. Smith, "The Evolution of Mind in Animals." Cambridge, 1915, p. 23.) Cf. the statement of Leibnitz:—"The mental life of animals shows itself to be parallel in its development to the differentiation of the nervous system; the faculties of human individuals appear to correspond to a full development of the brain." (H. Munsterberg, "Psychology and Physiology," p. 41.)

† Sir E. Ray Lankester, Roy. Soc. (Lond.) March 11, 1915.

‡ I have gone into this matter recently elsewhere (Bibliography 8, p. 261 *et passim.*)

remove it to a position a step higher in the evolutionary series than its fellows. In like manner I consider that a Foraminifer which selects a sponge-spicule of a certain length and uses it as a "flying buttress" to keep it mouth-upwards, or as a "catamaran spar" to prevent it from sinking in the ooze which stifles its less "intelligent" congeners, affords evidence of such purposive intelligence. Of however low an order it may be, *that* is the measure of intelligence required by that organism to give it an advantage over its fellows in the struggle for life. If the "catamaran spar" or "flying buttress" were part of the organism itself, and not selected and brought in from outside, the case would be merely parallel to that of the deep-sea sponges of the "Crinorhiza" type described by Professor Dendy,* but it is not.

Another equally distinguished Zoologist has met me with the argument that if my standpoint is a tenable one, I might with equal reason claim purpose and intelligence as responsible for the marvellous mechanical adaptations of certain vegetable seeds, by which their transport to new ground is effectuated—as, for instance (to quote a striking and familiar case), the parachutes of some of the Tragopogons.† I entirely repudiated the suggestion in a recent Lecture.‡ To say that in the vast economy of Nature the development of certain bodily attributes (being parts of the organism itself) leads to the survival and propagation of the fittest, is to enunciate the baldest of truisms, and such development in the vegetable kingdom has nothing in common with the purpose and intelligence displayed, *exempli gratia*, by those advanced individuals of the Foraminiferal genus *Crithionina*, which protect themselves with a hedge-hog coat of sharply-pointed sponge-spicules from the depredations of parasitic worms. But even my genial and distinguished critic, Dr. Chalmers Mitchell, supplies me, in another place, with a "Credo" which softens his kindly but incisive criticisms. He says:—"I believe with Darwin that as the

* A. Dendy, "Outlines of Evolutionary Biology." London, 1912, p. 420.

† "If consciousness and freedom, purpose and intelligence, are to be ascribed to lowly animals, I can see no reason why they should be withheld from the vegetable kingdom." (Chalmers Mitchell, op. cit., p. 96.) He cites the tropism of a planted bean whose shoot makes for the light, which tempts me to repeat the *reductio ad absurdum* in which I recently indulged in connexion with this useful vegetable. (Cf. Bibliography 7, p. 11.) At the same time, I am quite conscious that a botanist pursuing this inquiry along the lines indicated by his especial branch of science, must find remarkable data among his observations of many tropical plants which make purposive use of extraneous materials occurring in their environment. To quote familiar examples nearer home, one cannot but be impressed by the actions of insectivorous plants, and the determined upward thrust of a runner-bean tendril when a wire is stretched above it, and beyond its reach when merely assisted by wind action. Mr. Clement Reid, F.R.S., has been good enough to call my attention to some very remarkable phenomena afforded by the highly specialized utilization of lime by the *Characeæ* for the purpose of stiffening their stems, his observations upon which "Behaviourists" must await with eager anticipation.

‡ Bibliography 7.

body of man has been evolved from the body of animals, so the intellectual, emotional, and moral faculties of man have been evolved from the qualities of animals."* I ask again, with great respect, at what point in the Zoological record does that new departure in Evolution commence?

Whilst naturally shrinking from the introduction into this thesis of the most highly controversial question in modern Biology, namely, the phenomenon of the Human Soul, one cannot but recognize that the two postulates have much in common, and I do not think that I am forcing comparisons when I say that the evolution of what we are agreed to describe as the Soul is inseparably bound up with that which we are agreed to describe as Intelligence—in fact, "The Intelligent Soul" has assumed the purple as a text-phrase. Haynes, in criticizing Father Michael Maher's "Psychology" in a recent and scholarly opusculum,† observes:—"It is clear that Father Maher cannot demonstrate the immortality of the human soul without an act of special creation taking place at a particular moment unknown to us, when our last simian ancestor became our first human ancestor." And, in my opinion, he puts the case with great lucidity in a later passage:—"The evolution of mind not only shows a complete continuity between man and the animals, but it also shows that man only rises above the animals by reason of his cerebral development."‡

We hark back to the celebrated aphorism of Descartes, "Cogito, ergo sum" ("I think, therefore I am"); to which we may add that we are therefore, as Huxley has said, "the only *consciously* intelligent denizens of this world."§ It was a year after this was written, that P. H. Gosse, than whom no keener observer of marine organisms ever lived, said ‖: "The more I study the lower animals, the more firmly am I persuaded of the existence in them of psychical faculties, such as consciousness, intelligence, and choice, and *that* even in those forms in which as yet no nervous centres have been detected."

To sum up the matter in a few words, a study of the Reticularian Rhizopods extending over some thirty years has brought me to the conclusion that there appears to be no organism in the Animal Kingdom, however simple be its structure, *which lives a life of its own independently of any other organism*, which is not capable of developing functions and behaviour (including the adaptation of extraneous matters to its use and protection), which in the Metazoa might be called, and would properly be so called, Phenomena of Purpose and Intelligence.

* Op. cit., p. 99.
† E. S. P. Haynes, "The Belief in Immortality." London, 1913, p. 70.
‡ Op. cit., p. 88.
§ T. H. Huxley, Essays, vii. (1910) p. 153.
‖ P. H. Gosse, "A Year at the Shore." London, 1865, p. 247.

Note.—The eminent Rhizopodist Mons. E. Penard made a statement some ten years ago which I must allow myself to translate by way of post-scriptum. "If we wish to adopt the chemico-physical theory so much in favour nowadays, according to which everything in the lower beings is but mechanical reaction, it is necessary to apply the theory consistently, to examine the higher animals as well as the others, and we shall then be forced to recognize that between the top and the bottom of the physical scale there is only a descending gradation. Hence, according to this theory, the Savant solving a problem should only differ from the Protist in the greater complexity of the physico-chemical reactions. If, on the contrary, one is led to see something more than matter in the highest manifestations of human thought, this something must likewise be admitted for the beings lowest in the scale. . . . Finally, we cannot deny to these organisms a certain self-consciousness, and a knowledge of what they must do or avoid." ("*Les Héliozoaires d'Eau Douce.*" Geneva, 1904 p. 68.)

Whilst these pages have been passing through the press I have been asked by several correspondents what is the next stage in the investigation of these phenomena, leading to a further elucidation of the principles involved. It is, naturally, the investigation of the nature of protoplasm in unicellular organisms. The steps to be taken are adumbrated in J. E. Barnard's paper, "X-rays in Relation to Microscopy" (see this Journal, 1915, p. 1), and my observations thereupon (loc. cit., p. 87), and in Prof. E. A. Minchin's Presidential Address (Brit. Assoc., Manchester, 1915, Section D). Prof. J. Arthur Thomson has favoured me with the Syllabus of his Gifford Lectures (St. Andrews, 1915), and many illuminating notes upon the subject of the present paper. These Lectures when published will necessarily occupy an important place in the argument which I am bringing forward.

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NOTE.

Royal Microscopical Standards for Eye-pieces and Substage.

THE Standards for Eye-pieces adopted by the R.M.S. in 1899 * were four in number :—

No. 1.	0·9175	in.	=	23·300	mm.
No. 2.	1·04	,,	=	26·416	,,
No. 3.	1·27	,,	=	32·258	,,
No. 4.	1·41	,,	=	35·814	,,

The size being the internal diameter of the draw-tube, and the tightness of the fit being left to the manufacturer.

The standard size for the internal diameter of the Substage-fitting was fixed at 1·527 in.; this size had been used by the English trade for many years, the variation amongst different makers being not more than a few thousandths of an inch.

A set of Plug and Ring Gauges for the above sizes were obtained, and these have been kept for reference at the Society's rooms.

The Council of the Society have now made an arrangement with the Director of the National Physical Laboratory whereby the gauges have been deposited at the National Physical Laboratory, and makers' gauges may be compared with the standards on payment of a small fee.

At the present time practically only two Eye-piece Standards are in general use, viz. Nos. 1 and 3, and the Council recommend that these should be known respectively as the Small and Large size R.M.S. Standard Eye-pieces.†

* See Trans. of the Royal Micr. Society, 1900, p. 147.

† For Specification of Royal Microscopical Society Standard Screw Thread for Objectives, see 1915, p. 230.

SUMMARY OF CURRENT RESEARCHES

RELATING TO

ZOOLOGY AND BOTANY

(PRINCIPALLY INVERTEBRATA AND CRYPTOGAMIA),

MICROSCOPY, ETC.*

ZOOLOGY.

VERTEBRATA.

a. Embryology.†

Development of Limbs in Ox and Pig.‡—N. Suschkina-Popowa has studied the development of the extremities in *Bos* and *Sus*, and has compared the ontogeny with what can be inferred from the palæontological series in regard to the phylogeny. Certain events take place in ontogeny in the same order as in phylogeny. Thus there may be noted the disappearance of the first digit, the coalescence of certain carpal and tarsal elements, and the coalescence of the median metapodials—first in the hind limb and then in the fore limb. Historically, the first digit of the hind leg disappeared earlier than the first digit in the fore leg, and it is relatively late of appearing in ontogeny.

In some respects the ontogenetic picture differs from the phylogenetic. In the history of Artiodactyls the trapezium remains for a long time persistent; sometimes, even in recent Cervicornia, it remains after the fusion of trapezoid and magnum. But in the ontogeny of *Bos* this element does not appear. The fibula becomes interrupted in the ontogeny of *Bos* after the fusion of the ulna with the radius. But it is otherwise in the phylogenetic history.

The reduction of the first two and the lateral toes is condensed in the individual development. Historically, the first toe disappears first; the lateral toes retain their original thickness and length after the complete disappearance of the first toe; later on they also begin to dwindle. But in the individual development of *Bos* the first toe and the lateral

* The Society are not intended to be denoted by the editorial "we," and they do not hold themselves responsible for the views of the authors of the papers noted, nor for any claim to novelty or otherwise made by them. The object of this part of the Journal is to present a summary of the papers *as actually published*, and to describe and illustrate Instruments, Apparatus, etc., which are either new or have not been previously described in this country.

† This section includes not only papers relating to Embryology properly so-called, but also those dealing with Evolution, Development, Reproduction, and allied subjects.

‡ Bull. Soc. Imp. Nat. Moscow, xxviii. (1915) pp. 209–78 (2 pls.).

toes are rudimentary from their very start; the lateral toes appear much thinner and shorter than the middle toes, even in the earliest stages when the first toe still exists. Only in the much greater reduction of the first toe do we find an indication of the fact that in the history of the limb it was reduced at much earlier date than the lateral digits.

Metacarpal II and the trapezoid, metacarpal IV and the unciform, metatarsal IV and the cuboid, form single rays in their earliest primordia, and there is a subsequent separation of the carpal or tarsal element from the metapodial. This could not be represented in the phylogenetic series, being for mechanical reasons impossible. As a mode of development it is well known in reptiles. When metacarpal II is separated off from the trapezoid, it remains directed towards the trapezoid, and to it only, a characteristic of the adaptively reduced extremity. It becomes subsequently shunted to the volar side of the median metapodials.

The specializations of the limb of *Sus* occur ontogenetically very much in the same succession as those of *Bos*, and in a similar relation to the palæontological series. Noteworthy are the relations of the second metapodial element in both limbs. Metacarpal II is at first connected with the trapezoid; later on the two elements are separated, then the metacarpal II is shunted first in the direction of the axis of the limb and then back towards the median margin. The position of metacarpal II shows the following stages: (1) association with trapezoid, (2) relation with the os magnum as well, and (3) a connexion with the trapezoid (and trapezium), but not with the magnum, which is wholly occupied by the third metacarpal. The second stage marks a condition of non-adaptive reduction, the third of adaptive reduction.

Similar conditions obtain in the hind leg. The second metatarsal is laid down in connexion with the second cuneiform. Then it is separated off and shunted laterally, becoming directed to the third cuneiform. Finally, it comes back again to the second cuneiform, the third being wholly occupied by the third metatarsal. The second stage marks non-adaptive, the third adaptive reduction.

These movements of the second metapodial ray seem to be quite unnecessary for the attainment of the final result. In *Bos* they do not occur, and the first position is the final one. The movements can hardly be referred to purely developmental conditions, e.g. to strong growth of the third metapodial. This might compel the second metapodial to its final position, but the lateral movement remains unexplained. It is probable that an explanation is to be found in the phylogeny, i.e. in the assumption that *Sus* in its phylogenetic history passed through a primary non-adaptive stage, such as may be seen in *Chœrotherium* in the fore limb. In Amniota generally the hind limb appears to change more rapidly in phylogeny than does the fore limb. It may be said that the ontogeny of *Sus* compared with that of *Bos* shows more traces of the primitive serial arrangement of the basipodium.

The astragalus seems to represent the intermedium. At the end of the tibia, in the position of a tibiale, there is no proximal element laid down. It is only subsequently that the astragalus gets pushed into or grows into this position. No centrale carpi was to be found. Some elements of the metapodium are, in their primordium, in union with

corresponding elements of the basipodium. This association of certain metapodials and certain basipodials is of widespread occurrence in development.

Erythroblasts of Pig Embryo.*—Victor E. Emmel finds that the originally more or less spherical cell body changes to a flattened biconcave disk, or even concavo-convex cup. The nuclei decrease in size, become compact, tend to be flattened, and lie excentrically at one side. This nuclear side tends to swing undermost. The erythroblast sometimes shows a small pointed cytoplasmic process projecting from the surface; it may have to do with certain conditions attending the final division.

The non-nucleated erythroblasts or plastids vary from rounded to biconcave disks and cup-shaped elements. No conclusive evidence was obtained indicating the origin of plastids by the extrusion of the nucleus from the erythroblasts or of the disintegration of the nucleus within the cell. On the contrary, a process was repeatedly observed and studied in vitro, in which there occurred a constriction of the cytoplasm in the region between the nuclear and cytoplasmic poles of the erythroblast, which, when completed, resulted in the division of the cell into two parts, the one a nucleated structure, the other a non-nucleated hæmoglobin-containing corpuscle. In the embryo corroboration of this process of cytoplasmic constriction was obtained. In brief, as against the prevalent views of nuclear extrusion and intracellular disintegration, the author upholds the view that non-nucleated erythrocytes arise by a process of cytoplasmic constriction.

Fœtus of Sperm Whale.†—Frank E. Beddard has studied a fœtus of *Physeter macrocephalus*, and attention may be directed to a few of his results. The form is very markedly piscine, the characteristic and enormous head of the adult being not at all conspicuous. Indeed the head was roughly only one-fourth of the total body-length. A very interesting point is the presence of what appear to be two nostrils, that on the right-hand side (which disappears) being rather shorter and shallower. The relative smallness of the lung is commented on, and the observer discusses a body which he interprets as a second lung lobe. The remarkable fixed looping or festooning of the small intestine is described.

Correlation between Egg-laying and Yellow Pigment in Fowl.‡ A. F. Blakeslee and D. E. Warner bring forward data which indicate a connexion between the amount of yellow pigment showing in a hen and her previous laying activity. The most natural assumption is that laying removes yellow pigment with the yolks more rapidly than it can be replaced by the normal metabolism, and in consequence the ear-lobes, the beak and the legs become pale by this subtraction of pigment. It is true that environmental factors may influence the yellow pigmentation, and sickly birds may be pale though not in a laying condition. But, in

* Amer. Journ. Anat., xvi. (1914) pp. 127–204 (5 pls.).
† Ann. Durban Museum, i. (1915) pp. 107–24 (1 pl. and 9 figs.).
‡ Amer. Nat., xlix. (1915) pp. 360–68.

the material investigated, the authors find that variation in the laying activity is the prime cause of the changes in yellow pigmentation in the domestic fowl.

Influence of Temperature on Rate of Development of Fishes.*—A. C. Johansen and A. Krogh have repeated Dannevig's experiments on the influence of temperature on the rate of development of fish eggs, and confirm them in regard to the plaice. The increase in the rate of development with a rise of temperature is proportional to the increase in the temperature. In other words, the curve expressing the relation between temperature and rate is a straight line. It was also shown that a low oxygen pressure has a retarding influence on development.

Influence of Temperature on Rate of Development.†—August Krogh has experimented with the eggs of frogs, fishes, and water-beetles, and has obtained data as to rates of segmentation of the eggs of sea-urchins, in order to find out how far they illustrate van't Hoff's formula. He finds that the relation between the temperature and the rate of development cannot be expressed, even approximately, by van't Hoff's formula. In the cases tested the relation is algebraic over a range of temperatures which corresponds approximately to that at which normal development can take place, and the curve representing the relation is consequently a straight line.

Larval Polypterus.‡—F. Guitel has made a study of a larval stage of *Polypterus senegalus*, 59 mm. in length, said to have come from Lake Tchad. He describes the fin-rays, the scales, the pores of the lateral line. On the head there are 17 pores in the preopercular-mandibular series, 12 in the two supra-orbital series, 26 in the two infra-orbital series, 3 in the supra-temporal series, 58 altogether. The minute structure of the scales is discussed, and the kidneys are briefly described.

Peristomal Mesoderm and Tail in Lamprey.§—S. Hatta describes the origin of the peristomal mesoderm in *Lampetra mitsukurii*, a Japanese lamprey. The outer and inner layers roofing over the archenteron in front of the dorsal blastoporic lip are added to by the posterior growth of the dorsal and lateral lips, by which the blastopore is reduced. During the reduction of the blastopore, in the inner layer which passes round the blastoporic lips into the outer layer, there can always be distinguished three divisions: the median stem in front of the dorsal blastoporic lip and two limbs behind it, the latter constituting what is known as the peristomal mesoderm.

Before the blastopore is completely closed, the hindmost part of the peristomal mesoderm undergoes peculiar changes. The outer layer of the ventral blastoporic lip, the ectoderm, sinks in and forms a short median, longitudinal slit, the proctodæum. The invaginated proctodæum divides the peristomal mesoderm into two tail wings or lobes

* Publications de Circonstance, No. 68, Conseil Internat. pour l'Explor. de la Mer. Copenhagen, 1914, pp. 1–44 (14 figs.).
† Zeitschr. allg. Physiol., xvi. (1914) pp. 163–77 (8 figs.).
‡ Arch. Zool. Exper., liv. (1914) pp. 411–37 (2 pls. and 12 figs.).
§ Annot. Zool. Japon., ix. (1915) pp. 49–62 (3 figs.).

which eventually coalesce. Between the tail lobes the neurenteric canal is probably represented. The hindmost part of the proctodæum persists as the permanent anus. The produced hind extremity of the embryo, which results from a coalescence of the tail lobes, constitutes the commencing postanal section of the body, i.e. the rudiment of the tail or tail-bud. The postanal gut is a new formation, secondarily growing out of the hind wall of the anal gut. The dorsal series of organs in the tail, which are formed behind the blastopore in connexion with the postanal gut, are also of the nature of a new formation. Thus the tail in the lamprey, which is not more than one-eighth of the total length, is a secondary formation. It is to be regarded as the dorsal outgrowth of the blastoporic lip. Its development takes place only after the embryonic organs are established in the rest of the body—that is, in the post-embryonic larval stage.

Chromosomes and Mendelian Inheritance.*—J. H. Schaffner discusses the chromosomes with a view to emphasizing the remarkable parallelism between the activities of the complicated mechanism of nuclear division, and the predictable phenomena of Mendelian inheritance, summarizing as follows: The chromosomes normally function as individuals, and are segregated as such at each karyokinesis. The chromosomes do not conjugate or fuse, nor does their material mix in the fertilization stage; but each chromosome is carried through the zygote stage as a definite individual. In the reduction division the chromosomes show themselves to be definitely paired; and the $2x$ number of the zygotic individual represents two definite sets or complements of chromosomes, each one of the one set having its synaptic mate in the other. A specific attraction develops between each pair of synaptic mates during the prophases of reduction, resulting in an end-to-end fusion in pairs and a subsequent folding side by side, so that a bivalent chromosome represents synaptic univalents fused longitudinally, at least in the ordinary elongated types of chromosome. The segregation of the univalents during reduction is according to the law of chance; therefore, each daughter-cell receives a full (x) complement of univalents, some of the set being descendants of those brought into the zygote by the parent-egg and some by the sperm.

These processes are in harmony with the observed phenomena of Mendelian inheritance.

Reproduction, Heredity, and Death.†—V. Hensen discusses these subjects with special reference to marine organisms. The conditions of life in the open sea are on the whole simpler than elsewhere, and investigation is easier. Death is correlated with reproduction, and without it—especially old-age death—reproduction would in early days have become impossible in the crowded abundance of the open sea. The death of the persona is to be distinguished from the death of the personal form. In asexual reproduction and parthenogenesis the personal form may be continued year after year without change in the offspring; but in cross-fertilization or allogamy a new form arises. In Protists

* Ohio Nat., xv. (1915) pp. 509–18 (1 fig.).
† Wiss. Meeresuntersuch. Kiel, xvi. (1914) pp. 1–84 (20 figs.).

there is often no death of the persona till sexual reproduction occurs. The personal form may disappear periodically, but this can be evaded artificially.

Death from old age is very general; it is abetted by the voracity of other organisms, by parasitic and other diseases, by environmental vicissitudes, by scarcity of food. In fishes the vast majority die young —of hunger, external vicissitudes, and disease. Death at the hands of other organisms is much less general than is usually supposed. Natural death—as distinguished from violent death, or death due to parasites and microbes—may be brought about by lack of nutrition, accumulation of poisonous waste products in the medium, and by the arrears of wear and tear. The first two are not so fundamental as the third, which is primary. The hypothesis is advanced that there is with growing age an accumulation of waste-products, which may become particularly associated with the solid substances of the nucleus. Various waste-products —the dross of the combustion—encumber the organism as age goes on, though they are often effectively dealt with.

The function of the nucleus is discussed at length, especially as regards the cell-ferments. The nucleus collects these and modifies them and returns them to the cytoplasm. Great importance is attached to the granules or chromioles in the chromatin bands, which divide severally into two and are equally distributed to the daughter-cells. The chromioles are the chief vehicles of the hereditary primordia.

In regard to heredity a sharp distinction is drawn between the inheritance of type, for which the organization of the cytoplasm is very important, and personal inheritance, which altogether depends on the nucleus. The chromioles which bear the hereditary qualities must be thought of as having definite structural organization, as distinguished from ferments. The new person that arises in cross-fertilization has its structural basis in the chromioles.

Rejuvenescence has for its chief rôle the avoidance or removal of waste-products in the nucleus. It may occur apart from sexual reproduction, e.g. by elimination of parts of the nucleus and a change in the metabolism. It occurs in sexual reproduction in the giving off of polar bodies, in the change in the composition of the zygote, and in changes of metabolism. In fertilization there should be distinguished: (1) the stimulus to development; (2) the formation of a new person; and (3) rejuvenescence. The author concludes his essay with a discussion of Mendelism, inbreeding, selection, mutation, and the origin of species.

b. Histology.

The Evolution of the Cell.*—The late Prof. E. A. Minchin emphasized the idea of the cell as a complete organism, whether maintaining itself singly and independently, or in union with other similar but individually specialized cells. He could not, however, regard the cell in multicellular organisms as anything like the primordial unit or starting-point in the evolution of organisms. It is necessary to study the Protista to find relatively simple forms. In some of these the

* Pres. Address, Section D, Brit. Assoc., 1915, pp. 1–28.

generalization "omnis nucleus e nucleo" does not hold, for the nucleus may arise *de novo* from extra-nuclear (chromidial) chromatin. In the Protist cells a distinct nuclear membrane may be entirely absent; the chromatin is not necessarily confined to the nucleus; the linin (alveolar) framework of the nucleus is but little in evidence, if present at all; the chromatin may lie simply in a vacuole of nuclear sap; if a true nucleus is present it seldom shows a true (plastin) nucleolus, but usually a karyosome or chromatin nucleolus; or it may be granular, consisting of a clump of small grains of chromatin. Many observations have shown that the nucleus during life is undergoing continual internal movements and rearrangements of its parts, and is by no means at rest.

The simplest body that can be recognized as a nucleus, distinct from chromidia scattered in the cytoplasm, is a mass of chromatin or a clump of chromatin-grains supported on a framework and lodged in a special vacuole in the cytoplasm. From this type the complicated forms may be derived. But it must be noted that the nucleus is not a mass of chromatin, but a cell-organ, of greater or less structural complexity, and of unique function.

Too much emphasis has been laid on the staining-reactions of chromatin, but these are an "accident," though it may be an "inseparable accident," not a "difference," which can be used to frame a logical definition. Chromatin is rich in phosphorus-compounds, and resistent to digestion, but the only criterion is its behaviour, its relations to the activity and development of the organism. In some simple Protists, however, without definite compact nuclei, the identification of chromatin may be very difficult. To a large extent we are thrown back on staining reactions, and on the behaviour of the grains in question during the process of fission.

The cell is an organism, and often very complex in structure and function. "The vital processes exhibited by the cell indicate a complexity of organization and a minuteness in the details of its mechanism which transcend our comprehension and baffle the human imagination, to the same extent as do the immensities of the stellar universe." Thus the phenomena of karyokinesis and maturation "give us, as it were, a glimpse into the workshop of life and teach us that the subtlety and intricacy of the cell-microcosm can scarcely be exaggerated."

Without losing sight of the fact that the various parts of the cell are indispensable for the maintenance of life, we may ask which are the phylogenetically older. The cytoplasmic and chromatinic constituents may have arisen as differentiations of some primitive substance, which was neither the one or the other; or one of the two constituents may have been evolved from the other. No concrete foundation can be found for the view that cytoplasm and chromatin have a common origin in "plasson." Haeckel's Monera, as defined by him, are fictitious. All those that have been recognized have been found to have nuclei or nuclear substance.

Boveri has suggested that chromosomes were primitively independent elementary organisms which now live symbiotically with protoplasm, and that the cell arose from a symbiosis between two kinds of simple organisms. Mereschkowsky has assumed a double origin for organisms, mycoplasm combining with amœboplasm. Biococci, minute ultra-

microscopic particles of mycoplasm, able to withstand high temperatures and absence of oxygen, and able to build up proteins and carbohydrates from inorganic materials, were incorporated by amœboid non-nucleated monera. Others formed free bacteria, whence arose Cyanophyceæ and fungi. Some Cyanophyceæ became symbiotic in nucleated cells, and thus, by double symbiogenesis, arose the vegetable kingdom. But there is no evidence of Mereschkowsky's non-nucleated monera. Minchin strongly supported the position that chromatin-elements represent the primary organisms, and that cytoplasm is secondary. As every living creature or microcosmic unit is marked by permanent specific individuality (in spite of metabolism, adaptability, and variability) it is clearer to speak of chromatinic elements, particles or units rather than of chromatin-substance.

The reasons for regarding the chromatinic elements as of primary importance are: the preponderating physiological rôle of the nucleus; the individualization of the chromatin particles—almost as if they were individuals; and the "immortality" of the chromatinic particles in the life-cycle of organisms generally. Particular individual chromosomes can be tracked throughout a life-cycle. In many cases every cell of the body has chromatinic elements from its two parents, and these maintain their specific individuality unimpaired. The chromatinic particles are the only constituents of the cell which maintain persistently and uninterruptedly their existence throughout the whole life-cycle of living organisms universally.

It is suggested, then, that the earliest living beings were minute, possibly ultra-microscopic particles which were of the nature of chromatin. Their analogues may be looked for in the somewhat dubious organisms called Chlamydozoa. They may be thought of as specks of a substance like chromatin, multiplying by binary fission, producing ferments, and building up protein molecules from the simplest inorganic substances. Evolution may have proceeded along two main lines—vegetative and predatory. On the latter line, the primitive organisms gained an enveloping matrix of protoplasm—the periplasm, either around each unit, or like a zooglœa. Thus arose the prototype of the animal, with amœboid movement, engulfing periplasmic processes, and digestive ferments. A pseudo-moneral or cytodal stage was reached with a number of chromatin-grains within the periplasm. The next stage was the organization of the grains into a definite nucleus; the cytode became a protocyte, the starting-point of many complications and elaborations. The chromatin-constituents of the cell are regarded as a number of minute granules, each representing a primitive living individual or biococcus. Another great step in evolution was the elaboration of karyokinesis, which in tissue-formation effects the precise partition of the chromatin-elements, because these determine the qualities and behaviour of the cells. The author also dealt with the divergence of animal and vegetable cells, and with the lines of differentiation in the Protozoa.

Permeability of Cytoplasm of Cells.*—G. L. Kite points out that the interior parts of cells are generally assumed to be freely permeable

* Amer. Journ. Physiol., xxxvii. (1915) pp. 282–99.

to dyes and crystalloids, the whole emphasis being placed on the properties of a hypothetical plasmatic membrane which is believed to be fundamentally different from the deeper parts of the cells. He has studied the permeability of the internal cytoplasm in eggs of starfish and other marine animals, muscle-cells of *Necturus*, cells of *Spirogyra*, and other cases.

He finds that the structural components of protoplasm vary greatly in their permeability to water, dyes and crystalloids: that impermeability or partial permeability to water, dyes and crystalloids is a property of all portions of protoplasmic gels; that the rate of penetration of protoplasm by dyes and crystalloids is, in general, inversely proportional to the concentration of the living gel; that the best vital stains known penetrate very slowly into such highly concentrated protoplasm as the epithelial and striped muscle-cells of *Necturus*; that the interior portions of the cytoplasm of the starfish egg, and probably the striped muscle-cell of *Necturus*, exhibit the same sort of osmotic properties as the surface.

Pyloric Musculature in Bears.*—H. Neuville gives a comparative account of the muscular specialization of the pyloric apparatus in different species of bears. In this respect the Ursidæ occupy an isolated position among Carnivores, but the polar bear is an annectant type towards Canidæ or perhaps towards Subursidæ. The pyloric musculature serves as a triturating apparatus as well as for constriction and dilatation. It reaches in Ursidæ a rare degree of perfection as compared with most other Mammals.

Integument of Plectognaths.†—Nils Rosen has studied a number of types. In all cases the corium consists of two distinct strata, an external one with abundant cells and few fibres, an internal one very rich in fibres. The fibres of the internal layer are arranged in bundles running in varying directions. In *Mola*, in which this part of the corium is enormously developed, the bundles have a winding irregular loop, and the corium becomes hard and tough. In Tetrodontidæ and Diodontidæ the bundles are also winding, but not so irregular, so that the skin is extensible. In Ostraciontidæ and Balistidæ the bundles are arranged in horizontal and vertical lamellæ.

In Molidæ and Ostraciontidæ the integumentary ossifications are large plates, which are connected with one another, and project in long spines or short tubercles, more or less piercing the epidermis. This is regarded by Rosen as the most primitive condition. In Balistidæ there are plates with small tubercles; the plates do not touch one another; they have an oblique vertical position as in ordinary Teleosts, but there are no scale-pockets. In some Balistidæ reduction of plates begins, and this reduction is most marked in Tetrodontidæ and Diodontidæ, where the plate is comparatively minute, while the spine is long. The reduction of the plates into spines is intimately connected with the development of the air-sac. In all the ossifications two layers can be

* Ann. Sci. Nat. (Zool.) xx. (1915) pp. 1–38 (3 pls. and 12 figs.).
† Arkiv Zool., viii. (1913) No. 10, pp. 1–29 (5 pls. and 8 figs.).

distinguished, the upper homogeneous, the lower fibrillated. In connexion with the development of the air-sac in Tetrodontidæ and Diodontidæ there is a special development of sub-cutaneous tissue, especially ventrally, and there is an outer circular layer or muscle around the body, and an internal longitudinal layer on the ventral surface. The Balistidæ, Diodontidæ, and Tetrodontidæ form a series. The Molidæ and Ostraciontidæ are more primitive.

c. General.

Olfactory Reactions in Amphibians.*—Jonathan Risser has made many experiments with adult and larval frogs and toads. In its method of obtaining food the toad seems to respond to the visual stimulus entirely. This stimulus is apparently effective only when it involves motion. It is not always followed by perfect reaction, for inappropriate substances are often taken. Rejection of such material occurs in compliance with mechanical or tactile stimulation.

The gustatory function does not seem to be of any importance in feeding. There is no proof that the epithelial end-plates of the mouth cavity are gustatory in function. Deglutition follows almost instantly on ingestion. Odours when in relation with food are not sufficiently deterrent in action to compel the toad to refuse such food. At present there is no evidence that odours in soil or water are effective in any degree on the olfactory organ of the toad.

In contrast with the tadpoles of the frog, the toad tadpole appears to have an olfactory sense, and the nasal openings are relatively larger. It is more than probable that toad tadpoles recognize certain foods and their odours. Organs of taste have not been demonstrated in the mouth of the tadpole.

The Anura have receptor organs identical with those found associated with the olfactory sense in the higher Vertebrates. The receptor peculiar to the olfactory organ of all Vertebrates consists of a neurone whose cell-body is peripheral in position. The distal portion of the neurone is characterized by the protoplasmic processes projecting above the level of the surrounding cells, while the proximal end is attenuated and gives rise to one of the fibres of the olfactory nerve. It was formerly supposed that such receptors responded to stimuli only when the cell surfaces were dry, but the work of Aronsohn and Veress has shown that in man and the higher Vertebrates the olfactory epithelium is bathed by glandular secretions, and whatever stimulus reaches the receptor must do so in the form of solutions. More recently, Baglioni, Parker, Sheldon and Copeland have shown that the stimuli inducing certain reactions in aquatic animals are identical with those noted in air-breathing animals. That well-defined and characteristic motor reactions have not yet been recognized in frogs and toads as results of stimuli varying in quality may be due to some defect in method.

What has been established is thus summarized. There is no evidence that toads react to olfactory stimuli pertaining to soil, water, etc. The character of the food is not differentiated by attendant odours to the

* Journ. Exper. Zool., xvi. (1914) pp. 617–52 (1 fig.).

degree that the adult toad thus distinguishes it. Substances of unusual character and odour, when associated with food, do not stimulate the olfactory organs in such a manner as to bring the toad to refuse the food. The presence of such substances in close proximity to the toad, and invisible because of darkness, are not repellent in effect on the toad. Odour-streams specific in character, made to flow over and into the nasal openings, stimulate the olfactory sense-organ, such stimulation causing definite motor activities to follow. Appropriate operations are confirmatory that the stimulation by such odour-stream is olfactory. Section of the olfactory tract inhibits the reactions. Olfactory stimulation and reactions are not affected by section of the ophthalmic branch of the trigeminal nerve. Under circumstances allowing discrimination the tadpoles of the toad prefer animal foods. Such discrimination appears to rest upon the appropriate stimulation of the olfactory receptor. Tadpoles of the toad show by proper reactions that animal food is recognized, although not visually perceptible. The receptor organ so stimulated must be a distance receptor, and thus is olfactory in function. In the metamorphosed toad the visual stimulus is the principal and guiding factor in procuring food. Therefore, it is inhibitory in relation to other stimuli and their resultant reactions.

Relation between Temperature and Standard Metabolism.*—August Krogh has experimented with frogs and a young dog with reference to the quantitative relation between temperature and standard metabolism. It is important to distinguish the influence through the nervous system from the direct influence on the rate of metabolism in the tissues. When an organ is resting, a certain amount of metabolism, the "basal" metabolism, continues to go on. There is a slow spontaneous disintegration of the unstable bodies, the explosion of which by nervous impulse constitutes activity. The influence of the temperature upon the rate of spontaneous disintegration is a fundamental problem, but it is difficult to secure the condition of basal metabolism for a long enough time. The author has studied what he calls "standard" metabolism—an approximation to the basal metabolism. It is obtained when no assimilation of food is taking place, when movements are prevented, and muscular tone either abolished or brought down to a minimum. The absorption of oxygen has been used as the index of the metabolism.

When animals are studied under the "standard" conditions—all nervous influences being abolished—the influence of temperature on the metabolism of an animal is regular and constant, and can be expressed in a definite curve, which is not a straight line and cannot be expressed either by Arrhenius's formula or by the rule of van't Hoff. The curves obtained for frogs and goldfishes and, in a single experiment, on a young dog are identical, while that for pupæ of mealworms is distinctly different, though of the same general type.

Relation between Temperature and Respiratory Exchange in Fishes.†—Richard Ege and August Krogh have tested the applicability

* Internat. Zeitschr. Phys.-Chem. Biol., i. (1914) pp. 491–508 (5 figs.).
† Internat. Rev. Hydrobiol., 1914, pp. 48–55 (3 figs.).

of van't Hoff's formula to the respiratory exchange in a goldfish. According to van't Hoff's formula, the velocity of a process increases in geometric progression when the temperature is increased in algebraic progression. In the twenty-two days during which the experiments were made, the gas exchange of the fish at a constant temperature remained practically unaltered. The same result was obtained with a narcotized fish (to eliminate voluntary muscular movements). Van't Hoff's rule does not apply. "Discrepancies of the same order as those met with in the present case between the observations and the van't Hoff curves, which are supposed to represent them, are the rule and not the exception with regard to biological processes."

Brain of a Fœtal Gorilla.*—R. Anthony gives an account of this very rare object of study. The probable age was between six and seven months. Compared with the brain of a human fœtus of corresponding age, it was not so high or so globular, the frontal region receded more, the lower orbital plane was less depressed, and the telencephalic flexure was less pronounced. In profile it recalled the endocranial casts of Quaternary man from la Chapelle-aux-Saints and la Quina. Minute details are given of the state of the various parts.

Morphology of the Coracoid.†—The late R. Lydekker contrasted the two main interpretations of the ventral elements or element in the shoulder-girdle of Vertebrates other than fishes. According to one view the posterior ventral bone in the Monotreme shoulder-girdle is the true coracoid, equivalent to the single ventral element in birds and post-Triassic reptiles. The anterior bone is designated precoracoid or epicoracoid. According to Lydekker (1893) the epicoracoid of Monotremes and Mammal-like reptiles corresponds to the coracoid process in man, and the posterior bone should be called metacoracoid. In birds and post-Triassic reptiles, the single ventral element should be also designated metacoracoid.

Williston has recently shown that when one of the two ventral elements disappears, it is the posterior that is lost. Consequently, Lydekker pointed out, "the element in birds and post-Triassic reptiles universally known as the coracoid is entitled to retain that designation, as being the homologue of the human coracoid process and its equivalent, the true coracoid of the Monotremes and Mammal-like reptiles."

Tunicata.

New Species of Agnesia from Japan.‡—Asajiro Oka describes *Agnesia himeboja* from the Bay of Tateyama. It is one of the Corellidæ, and the genus is marked by the entire absence of the inner longitudinal vessels on the branchial sac. Its occurrence in Japanese waters is interesting from the point of view of geographical distribution, for

* Comptes Rendus, clxi. (1915) pp. 153–5 (1 fig.).
† Proc. Zool. Soc., 1915, pp. 235–7 (2 figs.).
‡ Annot. Zool. Japon., ix. (1915) pp. 1–6 (3 figs.).

A. glaciata Michaelsen was found south of the Tierra del Fuego, and *A. septentrionalis* Huntsman on the west coast of Canada.

Simple Ascidians of New England and Adjacent Coasts.*—Willard G. Van Name deals with thirty-four species, distributed in six families and twelve genera. The most interesting form is Traustedt's genus *Bostrichobranchus*, which is evidently derived from the genus *Eugyra* Alder and Hancock, from which it differs in the multiplication of the infundibula of the branchial sac. According to the author, it is the most highly specialized genus of Ascidians. The peculiarities of the branchial sac are described at length. One species of *Tethyum* (*Styela*), namely, *T. mortenseni* Hartmeyer, is unusual in the degree of reduction of the folds of the branchial sac. A small species of the family Cæsiridæ (Molgulidæ), namely, *C. singularis* sp. n., has the gonads of a peculiar form, the folds of the branchial sac reduced to an unusual degree, and the tentacles unbranched. The last-mentioned character seems to be unique in the family.

INVERTEBRATA.

Mollusca.

Molluscan Fauna of Florida Oligocene.†—W. H. Dall gives an account of the Molluscan fauna of the *Orthaulax pugnax* zone of the Oligocene of Tampa, Florida. Many of the fossils have been replaced by casts of pure silex, and are famous for their beauty. These are of particular scientific importance as furnishing a key to the little understood succession of the Tertiary beds which fringe the islands of the West Indies and the encircling continental shores. The number of species and varieties of Molluscs now known from the zone is 312, and nearly two-thirds of these are peculiar to it. No fewer than 219 species were new to science when the zone was first explored by the United States Geological Survey, and ninety-five of these are described in this monograph.

γ. Gastropoda.

New Arctic Opisthobranch.‡—Nils Hy. Odhner describes *Ptisanula limnæoides* g. et sp. n., known first from Quaternary shell-deposits, and afterwards from specimens from Spitzbergen (dredged by Torell in 1858). A description is given of the shell, the radula, the alimentary canal, the nervous system, the sense-organs, and the gonads. The rhinophores of Opisthobranchs are particularly discussed. Although derived from a primarily indifferent cephalic lobe, they are not absolutely homologous throughout, for they have arisen from differently specialized parts of that lobe. The open rhinophores of Ascoglossa cannot be derived from the cylindrical foliated or smooth ones of Æolididæ. In the structure of the radula, in the absence of parapodia, operculum, tentacles, jaws and gizzard-plates, and also in the nervous and genital systems there is

* Proc. Boston Soc. Nat. Hist., xxxiv. (1912, received 1915) pp. 439–619 (31 pls.).
† Smithsonian Inst. Bull. No. 90 (1915) pp. 1–173 (26 pls.).
‡ Arkiv Zool. viii. (1914) No. 25, pp. 1–18 (1 pl.).

a very close agreement between *Ptisanula* and *Diaphana*, and the two may be kept apart from other Scaphandridæ and ranked (probably along with *Newnesia*) in a distinct family Diaphanidæ.

Arthropoda.

Phagocytic Reaction in Arthropods.*—W. R. Thompson has inquired into the occurrence of a phagocytic reaction on the part of insects and crustaceans to multicellular parasites (such as Hymenoptera, Diptera, Cirripedes, Nematodes and Acanthocephala), and to artificially introduced bodies such as insect larvæ. He finds that there is usually no phagocytic reaction in such cases. If the phagocytes accumulate around the parasite it is because the latter has determined a local destruction of the tissues or because it is dead. It is possible that the phagocytes may affect the invader by means of substances which they introduce into the blood of their host, but this has not been proved. Toxic substances may be produced by the elements of various tissues. The protective rôle of the chitinous cuticle may be correlated with a poorly developed phagocytosis.

α. Insecta.

Reproduction and Sex-dimorphism in Insects.†—Antonio Berlese has worked out a theory of reproduction and sex-dimorphism, with particular reference to insects. In Protozoa there is often a succession of agamic reproductions on the part of anasomatic individuals. but this may be interrupted by sexual or gametic reproduction. In Metazoa the individual is at one time an anasomatic element or gonocyte ; it develops into a heteroplastid histone. There may be alternation of agamosomes and gamosomes, and the former may in certain cases be incorporated along with the latter. A diagrammatic notation is introduced to express the different modes of reproduction. Among insects there may be reproduction at the ovum level (polyembryony), or in the larval stage (pædogenesis), or in adult life. The primary condition of sex-dimorphism is to be sought in the reproductive cells which determine the nature of the gamosome. In the "struggle for reproduction" those variations have been seized upon and established which have conduced to the more effective performance of the characteristic functions of the two sexes. A classification is given of the various secondary sex characters in insects, e.g. ornamental, seductive, provocative, signalling, accessory to copulation ; and illustrations are given of the very varied degrees of sex-dimorphism. But we cannot do more than direct attention to the general tenor of Berlese's paper.

Olfactory Sense in Honey-bee.‡—N. E. McIndoo gives a detailed account of the structure and distribution of the olfactory pores in the honey-bee, which has a very acute sense of smell. This sense is most highly developed in the drones and least developed in the queen, while that of the worker is scarcely inferior to that of the drone. Olfactory

* Bull. Soc. Zool. France, xl. (1915) pp. 63–8 (1 fig.).
† Redia, x. (1915) pp. 77–112 (6 figs.).
‡ Journ. Exper. Zool., xvi. (1914) pp. 265–346 (24 figs.).

pores are found on the bases of all four wings, widely scattered on the trochanter, and at the proximal ends of the femur and tibia of all six legs, and generally distributed on the shaft and lancets of the sting. Each pore is a chitinous structure connected with a bipolar sense-cell, the peripheral end of which comes into direct contact with the external air.

Immature Stages of Tenthredinoidea.*—Alex. D. MacGillivray gives a useful account of the details of the external characters of the larvæ of sawflies, and deals also with the varied modes of life and with the cocoons.

Life-history and Habits of Knapweed Gall-fly.†—J. T. Wadsworth has studied *Urophora solstitialis*, a Trypetid fly, which lays its eggs in the buds of the common weed *Centaurea nigra*, and thereby reduces the number of seeds by about 50 p.c. The stimulus produced by the presence of the larva in the embryonic tissue of the developing ovule, and in the hypertrophied receptacle, induces a reaction of the plant to form a structure that is possibly protective to the plant itself, but which is also at the same time exactly suited to the requirements of the fully-grown larva, forming as it does a very efficient means of protection during the prolonged period of hibernation. The egg-stage lasts for eight to twelve days, about midsummer; a feeding larval stage lasts for three months, from July to October; then follows a hibernating larval stage, from October to mid-May. The pupal stage lasts for four or five weeks, from mid-May to the end of June. The flies emerge from mid-June onwards, and probably live for about a month. All the stages are carefully described, as also the long three-jointed ovipositor, which is extended by pressure, presumably by muscular compression acting on some of the body-fluids.

Protective Coloration of Pupæ of Pieris brassicæ.‡—L. F. Hammond reports on some experiments which corroborate Prof. Poulton's well-known results. The colour of the pupa approximates in a considerable degree to that of its surroundings. The influence of the colour of the surroundings is exerted on the larva. It affects the larva during the third and fourth periods of its life—namely the period of rest and the period between spinning up and the actual pupation. The effect is greatest during the third period, and is brought about through the nervous system.

Gynandromorphous Lepidoptera.§—E. A. Cockayne reports a gynandromorphous specimen of *Agriades coridon*, predominantly female, but with male hair scales and androconia on the smaller left side, and a gynandromorphous hybrid between *Ithysia zonaria* ♂ and *Lycia hirtaria* ♀, resembling a female, but with the left antenna pectinated as in the male.

* Rep. Entomol. Soc. Ontario, No. 36 (1914) pp. 54–75 (1 pl.).
† Ann. Applied Bot., i. (1914) pp. 142–69 (2 pls. and 1 fig.).
‡ Proc. and Trans. Croydon Nat. Hist. Soc., viii. (1915) pp. 5–11.
§ Proc. Entomol. Soc. London, 1915, pp. xv–xvi, in Trans. Entomol. Soc. London, 1915.

Gynandromorphs of Drosophila ampelophila.* — F. N. Duncan has made a microscopic study of five gynandromorphs of *Drosophila ampelophila* in order to determine whether the gonads corresponded to the secondary sex characters expressed by the somatoplasm. He finds that the gonads of lateral gynandromorphs do not follow the separation of the somatic cells into a male and female side, but are always either male or female on both sides.

Apodous Insect Larvæ.† — D. Keilin refers to Dollo's ‡ conception of "the irreversibility of evolution"—that an organism cannot return even partially to a state previously realized in the series of its ancestors—and discusses in the light of it the disappearance of thoracic appendages in Dipterous larvæ. Reduction of limbs occurs in many larvæ that are parasitic in animals (e.g. in some Hymenoptera and Strepsiptera), or parasitic in plants (e.g. in some Hymenoptera and some Coleoptera and Lepidoptera, or living on food prepared by the adult, or burrowing in dead wood. The reduction is always secondary and usually adaptive. In some Dipterous larvæ, which are all apodous, the life is free, but this is a secondary return to freedom, a re-adaptation, and it has not been associated with a re-development of appendages. There are often ventral projections with hooks ; the mandibles may aid in locomotion, as in *Mycetobia* ; there may be various sorts of attaching organs, as in forms living in streams ; the larvæ of *Phora* use their mouth as a leech does ; and other cases are noticed. But the point is, that although there has been a return from a parasitic or xylophagous mode of life to freedom, there is not any trace of a reappearance of appendages. This illustrates Dollo's idea of irreversibility.

Structure of Glow-worm.§ — E. Bugnion discusses some points in regard to the structure of *Lampyris noctiluca*, especially in reference to the mouth-parts. The adults take almost no food, the larvæ devour small snails. Bugnion seems to believe in the paralyzing and liquefying effect of a poisonous secretion injected into the victims. The mandibles of the larva are, as Fabre said, perforated by a fine canal, and in *Lamprorhiza delarouzei* the same is true. In the abdomen, at the level of the anterior end of the stomach, there are two acinous glands which probably secrete the toxic and liquefying fluid. The duct probably opens at the base of the mandibles. The mandibular canals of the glow-worm differ from those of the larval ant-lion and *Dytiscus* in having no communication with the mouth. The liquefied food is taken in by the mouth, and the absorption is probably aided by the capillary action of numerous hairs about the mouth. There is a muscular gizzard at the entrance to the stomach. The mandibles of the adult are not traversed by a canal, and their tip seems to be incapable of piercing or tearing. Bugnion's results should be compared with those recently stated by Miss Kathleen Haddon,‖ with which they are not altogether in agreement.

* Amer. Nat., xlix. (1915) pp. 455–6.
† Bull. Soc. Zool. France, xl. (1915) pp. 38–43
‡ Bull. Soc. Belge Geol., vii. (1893) pp. 164–6, and Mem. Soc. Belge Geol., xxiii. (1909).
§ Proc.-Verb. Soc. Vaud. Sci. Nat., 1915, pp. 92–4, in Bull. Soc. Vaud., i. (1915).
‖ See this Journal, 1915, p. 252.

Influence of Temperature on Development of Mealworm.*—August Krogh has experimented with the pupæ of *Tenebrio molitor*, to see how the rate of development and the production of CO_2 are affected by different temperatures. He finds that the relation between the temperature and the rate of development cannot be expressed in terms of van't Hoff's formula, but between 18·5° and 28° the relation is algebraic, and the curve representing it is a straight line. Beyond these limits the curve is not straight, but bends upwards at the lower temperature and downwards at the higher. Normal development is still possible at temperatures between 15° and 33°.

In the metabolic activity of the pupæ of the mealworm three stages are recognizable, corresponding roughly to periods of disintegration of larval tissues, comparative rest, and formation of the tissues of the imago. The metabolism in the tissue disintegration period is practically of the same intensity as in the tissue formation period. The total amount of CO_2 produced during the pupal period is the same at all the temperatures tried (21°–33°). There is no optimum temperature with regard to metabolism. The relation between the temperature and the average CO_2 production per hour cannot, therefore, be expressed by van't Hoff's formula, but follows the same curve as that found for the rate of development. The relation between the temperature and the metabolism of cold-blooded animals is generally supposed to follow van't Hoff's law. As the above experiments plainly show, this assumption must be received with caution.

Spermatogenesis of Mole Cricket.†—D. Voïnov has made a study of the spermatogenesis of *Gryllotalpa vulgaris* which shows an interesting state of the chromosomes. The stage of multiplication of sperm-cells is in May, maturation is accomplished in July, the testes usually show nothing but ripe spermatozoa in August. Fifty specimens were studied and they showed great uniformity.

The resting spermatogonia show two nucleoli and a weak reticulum of linin with a very small number of chromatic granulations. The nucleoli are partly chromatic, partly plasmic. They are micro-chromosomes in Wilson's sense, and combine at the beginning of the prophasis to form a bivalent micro-chromosome, characteristic of the equatorial plate of the spermatogonia. After the mitosis they separate again and resume the aspect characteristic of the resting stage.

The equatorial spermatogonial plate shows fifteen univalent chromosomes, so with the bivalent micro-chromosome there are seventeen, which include twelve autosomes, a large and a small idiochromosome, and an accessory chromosome. Thus *Gryllotalpa* is one of the rare forms with three special types of chromosomes—micro-chromosomes, idiochromosomes and an accessory chromosome. It is also marked by the way in which the reduction from seventeen diploid chromosomes to seven haploid chromosomes is effected. All the spermatids have seven chromosomes, but there are four different categories, a sort of double dimorphism.

* Zeitschr. allg. Physiol., xvi. (1914) pp. 178–90 (3 figs.).
† Arch. Zool. Exper., liv. (1914) pp. 439–99 (3 pls.).

Stigmata of Dragon-fly Larvæ.*—Alvar Neander has examined a number of Æschnid and Libellulid larvæ and finds that they have an open tracheal system. During the larval life the stigmata undergo further development, and the first pair is most differentiated.

Prolapsus recti in Dragon-fly.†—Kan Oguma noted on a living dragon-fly. *Somatochlora viridiænea* Uhler, a white body hanging out at the anal end. A section showed that this was the hind intestine of the insect, torn off from the rest of the alimentary canal at the posterior end of the pylorus and completely evaginated through the anus. The sections proved that the gut had been turned inside out. It is suggested that the prolapsus may have something to do with the physiological state which leads to the ecdysis of the rectal tracheal gills during the metamorphosis.

Anoplura and Mallophaga from Zululand.‡—Vernon L. Kellogg and G. F. Ferris report on a collection of Anoplura from Zululand rodents and of Mallophaga from *Theristicus hagedash*, the Hadada Ibis. The Mallophaga include *Læmobothrium setigerum* Piaget, var. *africanum* var. nov., *L. setigerum* Piaget, var. *cubensis* var. nov. The Anoplura include *Polyplax otomydis* Cummings, *Holopleura intermedia* sp. n., *H. enormis* sp. n., a striking form, marked by the enormously prolonged, finger-like prolongations of the pleura.

New British Machilidæ.§—Anna J. Reilly describes *Petrobius vectensis* sp. n., from the Isle of Wight, and *Petromachilis longicornis* g. et sp. n., from Cumberland and Caldey Island, off South Wales. The new genus *Petromachilis* is intermediate between *Machilis* and *Petrobius*, agreeing with *Machilis* in having paired processes on both the eighth and ninth abdominal segments in the male, and with *Petrobius* in having no scales on the antennæ except on the two basal segments, while it is intermediate between the two genera with regard to the mandible. It may be distinguished from the other British genus of Machilidæ, *Præmachilis* Grassi, by the presence of two pairs of exsertile vesicles on the second to the fifth abdominal segments inclusive, *Præmachilis* having not more than one pair of vesicles on any abdominal segment.

δ. Arachnida.

Blood-Sucking Gamasid Mite on Couper's Snake.‖—Stanley Hirst describes *Ichoronyssus serpentium* sp. n. (?), five females of which were found on a Couper's Snake in the London Zoological Gardens. It is quite probable that the species may be the same as that to which the name *Dermanyssus natricis* was given in 1844 by Gervais, *Ophionyssus natricis* in 1884 by Mégnin. In having two dorsal shields and also minute intermediate platelets, the adult females present a strong resemblance to the protonymph stage of certain other species of *Ichoronyssus*, such as *I. bacoti* Hirst.

* Arkiv Zool., viii. (1913) No. 14, pp. 1-5 (2 figs.).
† Anat. Zool. Japon, ix. (1915) pp. 63-6 (3 figs.).
‡ Ann. Durban Mus., i. (1915) pp. 147-58 (2 pls.).
§ Ann. Nat. Hist., xvi. (1915) pp. 10-15 (5 pls.).
‖ Proc. Zool. Soc., 1915, pp. 383-6 (2 figs.).

ε. Crustacea.

Idotea hectica.*—Walter E. Collinge describes this imperfectly known species from the Atlantic. It belongs to that division of the genus *Idotea* which is characterized by the narrow, elongated, filiform body, and in which the epimera are either not visible dorsally, or else are very small. The division contains such species as *I. linearis* Linn., *I. indica* M.-Edwards, and *I. elongata* Miers.

Monograph on Phyllopoda conchostraca.†—Eug. Daday de Deés continues his systematic account of Phyllopods, and deals with the group "Conchostraca," which includes the families Lynceidæ, Limnadiidæ, Cyclestheriidæ, Cænestheriidæ, and Leptestheriidæ. In the present instalment the author discusses Cænestheriidæ, with the new genera *Cænestheria*, *Cænestheriella*, and *Eocyzicus*, and the genus *Estheria*, now called *Cyzicus* And.

Pelagic Entomostraca of Durban Bay.‡—G. Stewardson Brady reports on a collection of two species of Cladocera and fifty-four species of Copepoda. Among the Copepods are several new genera—*Metranura* (closely allied to *Paracalanus* and *Acrocalanus*), *Isocope* (differing from other Pontellidæ chiefly in the structure of the swimming feet and posterior antennæ), *Oithonopsis* (differing from *Oithona* in its remarkably short abdomen and in its posterior antennæ and mouth parts).

Entomostraca of the Albert Nyanza.§—W. A. Cunnington reports on a collection from this great lake which is but slightly known faunistically. In all only ten species are known, a small number when it is remembered that the lake has a superficial area of some 2000 miles. The species now reported were collected by Leiper and identified by Sars.

Parthenogenetic Generations of Daphnia.‖—A. M. Banta has succeeded in rearing as many as one hundred generations of *Daphnia pulex* without sexual forms, from large females taken from a pond in which there were no male or "winter" eggs to be found. Each line was propagated by selecting from the first brood of a young female when the brood was released from the pouch. Each individual was placed in a separate bottle with standard food and left undisturbed till the first brood appeared. There was no sign of decreased vigour or loss of vitality in the lines, and the author concludes that the sexual cycle in *D. pulex* is not an inherent necessary thing, but is determined by environment.

Northern and Arctic Fresh-water Ostracods.¶—Gunnar Alm records a large number of new localities (in Siberia, Nova Zembla, Finland, Greenland, Spitzbergen, etc.) for species of *Cypris*, *Eucypris*, *Cyclocypris*, *Candona*, and other fresh-water Ostracods. Some new

* Ann. Nat. Hist., xvi. (1915) pp. 162–4 (1 pl.).
† Ann. Sci. Nat. (Zool.) xx. (1915) pp. 39–192 (41 figs.).
‡ Ann. Durban Museum, i. (1915) pp. 134–46 (6 pls.).
§ Ann. Nat. Hist., xvi. (1915) pp. 80–3.
‖ Proc. Soc. Exp. Biol. Med., xi. (1914) pp. 180–2.
¶ Arkiv Zool., ix. (1914) No. 5, pp. 1–20 (1 pl. and 8 figs.).

species of *Eucypris* and *Candona* are described. In the case of *Eucypris affinis hirsuta* Fischer the males were found, which is rare among Cyprids. Males were also found in *Eucypris crassoides* sp. n. Apart from these two cases and *Cyprinotus incongruens*, males are known only in Southern regions.

Annulata.

Uncini of Annelids.*—M. Caullery has made a minute study of the uncini of the Terebellid genus *Pista*, which bear numerous denticulations at the apex and an inferior stalk (the so-called "Muskelforsatz"), more or less prolonged. For taxonomic purposes it is essential to examine methodically the uncini of the various segments of the thorax, especially in front, where highly differentiated uncini take the place of the setæ properly so called. The uncinus corresponds to the extremity of a hooked seta, such as is found in Clymeniæ, Capitellids, and Spionids. The stalk (tige) of the thoracic uncini is a vestige of the handle (hampe) of the primitive seta, and not a portion newly differentiated in connexion with the insertion of muscular fibres.

Pacific Polychæts.†—Aaron L. Treadwell reports on the Pacific Polychæts of the zoological museum of the University of California, and describes twelve new species—*Panthalis pacifica*, *Nereis notomacula*, *Spio acuta*, *Scolecolepis alaskensis*, *Polydora californica*, *Streblosoma crassibranchia*, *Trophonia minuta*, *T. inflata*, *Ophelina magna*, *O. mucronata*, *Laonome oculifera*, and *Branchiomma disparoculatum*. The author also describes ‡ two new Syllids—*Trypanosyllis adamanteus* sp. n. and the *Sacconereis* phase of *Autolytus varius* sp. n., both from San Francisco Bay.

Onuphidæ of North Sea.§—F. Eulenstein describes *Onuphis conchylega* M. Sars, *O. quadricuspis* G. O. Sars, and *Hyalinœcia tubicola* O. F. Müller, and pays particular attention to the jaw apparatus, the three sets of jaw muscles, the probably sensory neck-organ—a flat, strongly ciliated, narrow band below the posterior margin of the head-lobe. He also describes the oogenesis and the occurrence of nutritive cells which are to be regarded as abortive ova. In the ripe males there are such crowds of sperm-cells in the sexual segments that all the cœlomic cavity, even into the parapodia, is filled, and interesting sperm-filled diverticula bulge into the lumen of the gut.

Pelagic Annelids of Japan.‖—Akira Izuka reports on nine species of Alciopidæ and Tomopteridæ from Japanese waters. His collection includes *Vanadis grandis* sp. n. with no fewer than 688 segments, 408 mm. in total length, 1·3 mm. in breadth anteriorly, tapering to 0·8 mm. in about the 500th segment. The bright red eyes are relatively

* Bull. Soc. Zool. France, xl. (1915) pp. 68-78 (2 figs.).
† Publications Univ. California (Zool.), xiii. (1914) pp. 175–234 (2 pls.).
‡ Publications Univ. California (Zool.) xiii. (1914) pp. 235-8 (7 figs.).
§ Wiss. Meeresuntersuch. Kiel, xvi. (1914) pp. 131-72 (2 pls. and 8 figs.).
‖ Journ. Coll. Sci. Imp. Univ. Tokyo, xxxvi. (1914) Art. 5, pp. 1–14 (1 pl. and 1 fig.).

enormous, and touch one another on the dorsal median line of the prostomium. Each has a clear almost ventrally directed lens. Another new form of very slender body (0·5 mm. in breadth) is *Callizona japonica* sp. n., in which the prostomium is greatly prolonged anteriorly beyond the line of the eyes. The other new species is *Tomopteris pacifica*, in which the second tentacular cirri are about three-quarters as long as the body-proper, "rosette-form" organs are present on the first and second parapodia, there are fin-glands, and there is a slender tail-region of about one-third the length of the body.

Sipunculoids of North Sea and Baltic.*—J. Fischer deals with species of *Phascolosoma*, *Phascolion*, *Physcosoma*, *Aspidosiphon*, *Onchnesoma*, *Priapulus*, and *Halicryptus*, and gives an account of the shields which occur on *Aspidosiphon* at the two ends of the body. Each shield is composed of a number of closely-appressed chitinous plates. Each plate shows in cross-section a distinct concentric lamination. The plates arise by the deposition of laminæ from the hypodermis, which is a differentiation of the epidermis. It is probable that the function of the shields is protective. The animals often live in Gasteropod shells, and the anterior shield serves to close the aperture. In *Aspidosiphon mirabilis*, which lives in the shell of *Dentalium*, the posterior shield has a similar use. In some species, e.g. *A. venabulum*, living in shells of *Turritella*, the posterior shield is very weakly developed.

Nematohelminthes.

Migration of Larvæ of Onchocerca.†—William Nicoll discusses the migration of the larvæ of *Onchocerca gibsoni*, a parasite causing nodules in cattle in Australia. He has made a number of experiments which go to show that the larvæ can and do make their escape through the capsule of the nodule. They usually do so in small numbers, but the number may be considerable, and quite sufficient to ensure a moderate chance of a few being taken up by a blood-sucking or biting insect. The larvæ may even come through the skin, and might infect a non-biting insect; but in such a case it would be difficult to understand how re-inoculation could be effected. The larvæ are adapted for independent existence in water, and their life in water does not extend beyond two days. Notwithstanding these objections, water-borne infection cannot be ruled out as impossible. On the whole, however, insect-borne infection appears to present the greatest measure of probability.

In another paper ‡ the author takes a survey of the parasitic worms of tropical Queensland, calling attention to the hook-worms (*Ankylostomum duodenale* and *Necator americanus*), the rarity of tape-worms in man, the worm-nodules in cattle, the frequency of *Dirofilaria immitis* in the dog's heart and of *Gigantorhynchus moniliformis* in rats. The Echidna is infected by two species of *Cittotænia* and by a little red Nematode firmly coiled in a spiral and attached to the wall of the

* Wiss. Meeresuntersuch. Kiel, xvi. (1914) pp. 87–128 (1 pl. and 9 figs.).
† Ann. Trop. Med. Parasitology, viii. (1914) pp. 609–21.
‡ Med. Journ. Australia (Sept. 12, 1914) pp. 3–7.

intestine. He refers also to the remarkable Trematode, *Rhabdiopæus taylori*, described by S. J. Johnston, from the dugong, various eye-worms from birds, and the distinctive Trematodes found in fishes.

Free-living Nematodes of Switzerland.*—B. Hofmänner and R. Menzel give an account of the lacustrine and terrestrial Nematodes of Switzerland, and bring up the list to 110 species. A useful diagnostic key is given. Eighteen new forms are described and the new genus *Criconema* is established for small forms with a very markedly ringed cuticle, peculiar thickenings at the head end, and long fine spines at the mouth. The cuticular rings may be smooth (in *C. morgense*) or furnished with spine-like backward-directed processes (*C. guernei*). The latter (*Eubostrichus guerni* of Certes) was first found in Tierra del Fuego, subsequently by Richters on Kerguelen and Heard Island, and by Murray in Scotland.

Platyhelminthes.

New Cestode.†—A. R. Cooper describes *Haplobothrium globuliforme* g. et sp. n. from the duodenum of *Amia calva*, in which small plerocercoids were also found. The body is remarkable since the proglottides are marked externally only in the anterior portion of the strobila, beginning immediately behind the scolex. Here the proglottis is provided posteriorly with four ear-like appendages directed backwards, which may help in attachment, perhaps by forming temporary suckers or by using rows of spines arranged along their edges. Posteriorly these appendages disappear and the proglottides are marked only by the successive sets of gonads. The scolex differs but little, either internally or externally, from the foremost joints, the two suckers being somewhat feebly developed.

The musculature is particularly well expressed in the jointed region of the strobila. The external longitudinal fibres are quite distinct from the inner or longitudinal muscles of the parenchyma, but are confined to the anterior region of the strobila. The outer transverse series is divided into two sets on each surface of the proglottis, and the fibres are directed postero-laterally, decussating in the mid-line. The individual fibres of nearly all the groups of muscles are characterized by having their cortical or contractile layers divided up into a number of fibrils, which, however, still retain their connexions with the protoplasmic substance of the myoblasts.

The nervous system consists of two chief strands, situated laterally in the medullary parenchyma and united beneath the tip of the scolex to form a very small ganglionic ring. In the jointed portion of the strobila there are eight collateral strands, four located around each chief strand. The excretory system consists of one large median vessel—the equivalent of the usual dorsal pair—and two smaller vessels, situated laterally and ventrally. All unite in the scolex to form a median vesicle accommodated in the hollow behind the nerve-ring. There are numerous foramina secundaria and flame-cells. The genital organs are described

* Revue Suisse Zool., xxiii. (1915) pp. 109–243 (3 pls.).
† Trans. R. Canadian Inst., xxiv. (1915) pp. 81-119 (3 pls.).

in detail. They are simple and on the whole like those in *Dibothriocephalus latus* Linn. All the genital ducts are lined with a syncytial epithelium which becomes cuticular in certain regions (the cirrus and the entrance to the vagina). There is an associated migration of the epithelial nuclei through the basement-membrane and into the surrounding parenchymal cytoplasm. The eggs are ellipsoidal, with transparent shells and an operculum. The embryo shows an internal oncosphere and an external mantle, well supplied with cilia.

New Species of Zschokkeella.*—H. A. Baylis describes *Zschokkeella muricola* sp. n. from the intestine of a rat from the Gold Coast. The rat was probably *Epimys* (*Mus*) *rattus*, the black rat. When held up to the light the hinder segments of the worms appeared to be full of small rounded bodies, evidently "egg-capsules." These gave the worm a peculiar speckled appearance. The new species seems to be nearest *Inermicapsifer pyracis* v. Janicki, which Beddard has included in the genus *Zschokkeela*. The excretory system consists of a distinct pair of dorsal longitudinal vessels and a ventral network arranged on a regular plan, with a transverse vessel in each segment. Genital organs begin to appear in the neck before the segments become clearly defined. The testes are in two unequal groups, the larger group on the side remote from the genital pores. A small rounded receptaculum seminis is present, in addition to a fusiform expansion of the inner half of the vagina. The uterus is a branched tube at first, becoming a transverse sac; not persistent. Each of the many egg-capsules in the gravid segments contains about twenty eggs.

New Trematodes.†—G. A. MacCallum reports on some of the ectoparasitic Trematodes on fishes in the New York Aquarium. He refers to the opportunities sometimes afforded of observing the parasites alive. Thus crowds of *Microcotyle* may be seen sucking the blood from the gill-filaments and causing a suffocating outflow of mucus. The death of two snappers (*Priacanthus cruentatus*) fresh from the sea was certainly caused by species of *Diplectanum*. MacCallum describes *Diplectanum teuthis* sp. n. from the gills of *Teuthis hepatus*, *D. lactophrys* sp. n. from the gills of the cow-fish (*Lactophrys tricornis*), *D. balistes* sp.n. from the gills of a trigger-fish (*Balistes carolinensis*), *D. longiphallus* from the gills of a spade-fish (*Chætodipterus faber*). More striking, however, is the new genus *Atalostrophrion*, represented by *A. sardæ* from under the mucosa of the branchial cavity of the bonito (*Sarda sarda*), and by *A. promicrops* from the gills of a large Jew-fish (*Promicrops guttatus*). It is flat, ribbon-like, very narrow throughout, but attenuated towards the anterior end. The uterus consists of two or three tubes extending uncoiled nearly from one end to the other; the ovary is also tubular, but not nearly so long as the uterus; the vitellarium and vas deferens are also single tubes, the former nearly half as long as the uterus; the testis is also tubular, and the vas deferens extends through nearly three-fourths of the length of the worm to end at the genital atrium within the mouth.

* Ann. Nat. Hist., xvi. (1915) pp. 40–50 (1 pl.).
† Zoologica, i. No. 20 (1915) pp. 395–410 (7 figs.).

North American Larval Trematodes.*—W. W. Cort describes a large number of cercariæ, of Monostome, Amphistome, Distome, Echinostome, Microcercous, Furcocercous, Polyadenous, Ornate, and Microcotylous types. He distinguishes characters which foreshadow those of the adults and those peculiar to the larval existence. The classifications proposed by Lühe and Lebour are discussed.

Echinoderma.

Artificial Parthenogenesis of Sea-urchin Ova.†—A. P. Dustin has made a slight modification of Delage's method of inducing parthenogenetic development in sea-urchin ova. Delage added to 300 c.cm. of sea-water, 700 c.cm. of an isotonic solution of saccharose, 15 centigrams of tannin dissolved in distilled water, 3 c.cm. of normal ammoniacal solution. The ova were left for an hour in the mixture, then washed several times, and then placed in sea-water. Some hours later the first cleavages appeared.

Dustin diluted the mixture with an equal volume of sea-water, or with twice as much, and found that the first asters appeared in 1 hour or 1¼ hours, while the eggs were still in the diluted mixture. Very good results were also obtained by adding to Delage's mixture an equal volume of saccharose solution (388 per 1000), or twice as much. When the ova were replaced in sea-water they soon developed into larvæ.

Activation of Sea-urchin Ova.‡—A. Brachet has made a number of experiments on the ova of *Paracentrotus lividus*, treated for two minutes with butyric acid, after Loeb's method. 1. Some eggs after treatment were placed in sea-water containing spermatozoa; 60 to 70 p.c. formed a membrane, were fertilized, and developed into plutei. 2. Others, placed in pure sea-water, formed a typical fertilization membrane in less than two minutes. After ten minutes spermatozoa were added. In not more than 1 p.c. did a spermatozoon enter and induce segmentation. The others underwent the cytolysis characteristic of the action of butyric acid. 3. Another set of eggs placed in pure sea-water formed a membrane within twenty minutes. Spermatozoa were then added. As in the first set, 60 to 70 p.c. were fertilized and proceeded to develop. 4 and 5. In two other sets the eggs were kept thirty to forty minutes in the pure sea-water before spermatozoa were added. As in the second set, only about 1 p.c. were fertilized and proceeded to develop. 6. In another set the eggs remained fifty minutes in the pure sea-water. Almost all had then formed a membrane, and radiations had appeared around the nucleus. Nevertheless, after the addition of spermatozoa 60 to 70 p.c. were fertilized and proceeded to develop, as in sets 1 and 3. The same result followed when the ova were left for seventy minutes in the water.

The following conclusions are drawn. The fertilization membrane and the perivitelline fluid which accumulates beneath it do not form a

* Univ. Illinois Bull., xii. (1915) No. 45, pp. 1–86 (8 pls.).
† Comptes Rendus, clxi. (1915) pp. 356–9.
‡ Comptes Rendus, clxi. (1915) pp. 359–61.

true obstacle to fertilization. But the liquid is hurtful, as was seen by the arrest of the spermatozoa in lots 2, 4 and 5, noted above. Ova of the sea-urchin activated by butyric acid undergo cyclical changes in their cytoplasm, which are repeated twice in the first fifty minutes of their immersion in sea-water. At the beginning and end of each cycle the substance of the egg is permeable by a spermatozoon, which may complete the work of the parthenogenetic agent. In the intervals the substance of the egg is quite refractory, and the spermatozoa which are able to pass into the perivitelline liquid die there. The intimate changes in the egg are probably physical rather than chemical, and due to oxidations.

The radiation always observed in the ova fifty to eighty minutes after the beginning of activation do not hinder fertilization. In normal fertilization the activation does not close its first cycle, because it is continued directly into the phenomena preparatory to cleavage. The primary inhibition is definitive, and a belated polyspermy is impossible. Herlant has observed that the efficacy of Loeb's method has two optima, which correspond approximately to the two periods of ovum-receptivity which Brachet's experiments have disclosed.

Cœlentera.

Notes on Anemones.*—Richard Elmhirst notes that anemones with double disks may remain thus in captivity for years. A specimen of *Actinia equina* with two complete disks, mouths and sets of tentacles remained in the same state nearly four years. Another with two almost complete disks became normal again. A normal specimen put into a well-lit aquarium practically never closes its tentacles, but keeps them hanging limply down. It became olivaceous and its young are olivaceous, suiting the surroundings. One of the offspring divided across the base in about three months.

A specimen of *Urticina felina* was found in a sandy bay, where there were no stones, with its base swollen so as to anchor it firmly in the sand. A specimen of *Stomphia churchiæ* was twice observed in the mouth of a larger specimen, near which it habitually lived. There was no struggle, as though the larger were trying to eat the smaller. On the first occasion the observer freed the smaller one, on the second occasion it seemed to be dismissed by the larger one. In the case of *Peachia* there is a ciliary incurrent stream which wafts in diatoms and the like, and may also help in respiration. Individuals supplied with *Gammarus* and young fish a few days old did not capture them.

Note on Medusan Genus Stomolophus.†—Henry B. Bigelow notes the occurrence of specimens of *Stomolophus* in San Diego Bay, California, which differed strikingly in colour from their Atlantic ally, *S. meleagris* Agassiz. But the colour differences are not accompanied by any structural differences which would warrant specific separation. Three other forms of *Stomolophus* have been described—*S. fritillaria* Haeckel, *S. agaricus* Haeckel, and *S. chuni* Vanhöffen. But all must be

* Zoologist, 1915, pp. 1–4.
† Publications Univ. California (Zool.) xiii. (1914) pp. 239–41.

grouped as one species, *S. meleagris*; and the fact is interesting that this occurs both in the Pacific and Atlantic, but limited to American waters of comparatively high temperature in both. The genus is unknown elsewhere. As the same species occurs on both side of temperate and Central America, Mayer is justified in saying that it has remained unchanged since the closure of the Isthmus in Mesozoic times.

American Hydroids.*—Charles Cleveland Nutting continues his comprehensive monograph on American hydroids, and deals with the families Campanularidæ and Bonneviellidæ. He gives a morphological account of the Campanularidæ, and discusses their classification, recognizing the genera *Gonothyræa*, *Obelia*, *Obelaria*, *Campanularia*, *Clytia*, *Thaumantias*, *Silicularia*, and *Opthopyxis*. The small family of Bonneviellidæ is marked by the presence of a well-marked "veloid"—an ectodermic membrane stretching from the tentacle-bases over the real oral surface, leaving a circular aperture above the true oral opening, and thus forming a pre-oral cavity. Another feature is the absence of any proboscis. There are four American species of *Bonneviella*, the only genus.

Porifera.

Sponges of the Coasts of Ireland.†—Jane Stephens reports on the Triaxonida and some of the Tetraxonida from off the west and south-west coasts of Ireland. All except *Pachymatisma johnstonia* were taken in deep water. Five Triaxonida, eleven Tetractinellida, and twenty-seven Astromonaxinellida are dealt with. Of the sixteen Triaxonida and Tetractinellida, twelve are now recorded for the first time from the Irish area, and *Sidonops atlantica* is a new species. Among the Astromonaxonellida there are four new species—*Latrunculia normani*, *Cliona coralliophaga* (in *Lophohelia*), *Laxosuberites incrustans*, and *L. durus*; and a new genus, *Atergia*, is established for massive sessile Polymastidæ, without papillæ, with two kinds of spicules, tylostyli and oxea, the latter occurring scattered irregularly in the choanosome.

Protozoa.

Genetics of Ciliate Protozoa.‡—Clifford Dobell has written a commentary on the genetics of Ciliate Infusorians. He begins with the organization of a Ciliate and the chief events in its life. The body is generally asymmetric, with anterior and posterior ends, with dorsal, ventral (oral), and lateral regions, with contractile vesicles and other specialized parts, with two nuclei or systems of nuclei. Multiplication is usually effected by transverse fission, the meganucleus constricting, the micronucleus or micronuclei dividing mitotically. Most forms are able to encyst. In conjugation the protoplasm of the pair becomes continuous at the point of contact, and there is a migration of micronuclear elements. In *Vorticella* and its allies two conjugating individuals fuse

* Bull. Smithsonian Inst. U.S. Nat. Museum, pt. 3 (1915) pp. 1–118 (27 pls. and 70 figs.).

† Sci. Invest. Fisheries, Ireland, 1914, iv. (1915) pp. 1–43 (5 pls.).

‡ Journ. of Genetics, iv. (1914) pp. 131–89 (5 figs.).

completely. A "reduction" or halving of the chromosomes (meiosis) may occur during the micronuclear divisions which take place at the beginning of conjugation. It is possible that a certain amount of cytoplasm is exchanged during conjugation.

A Ciliate is a non-cellular complete organism, homologous with an entire metazoon, not with a cell of a metazoon. The meganuclear system is the equivalent of the nuclei of the somatic cells of a metazoon, and the micronuclear system of a Ciliate is the equivalent of the germ-cell nuclei of a metazoon. Conjugation is a process of reciprocal fertilization, coupled with a process of complete reorganization unlike anything known to occur in other organisms. The exconjugant is a zygote of a very remarkable kind, for it is the remains of the "parent" organism reorganized after the addition of a foreign nucleus. Forms like *Paramecium* may be regarded as hermaphrodite individuals; forms like *Vorticella* show male and female individuals. All "generations" are produced asexually, by fission or budding.

The second chapter deals with the life-cycle of a Ciliate according to Maupas. There is first a period of asexual multiplication and immaturity; then the organs become sexually mature and are able to conjugate; unless they conjugate they go on dividing; if conjugation does not occur there is more multiplication and senescence. Those which are able to conjugate successfully during the eugamic period become "karyogamically rejuvenated," or reorganized, and start another cycle of development. The period of a cycle depends on the rate of division, and this depends on four factors—the individual temperament of the species, its adaptation to its form of nutrition, the quality and quantity of the food, and the temperature. According to Maupas three conditions are necessary for conjugation—hunger, sexual maturity, and diversity of ancestry of the conjugants. Senescence is marked by decrease in size, nuclear degeneration, reduction of the mouth-parts and appendages, loss or inhibition of various functions, and sometimes by "morbid sexual hyperæsthesia," leading to abnormal and sterile conjugations between closely related individuals. It ends in death, which Maupas held to be as inevitable for *Paramecium* as for man.

The third chapter is devoted to the results of later investigators. As regards the asexual period it seems highly probable that "depression" or "senescence" in Ciliates is due to unhealthy surroundings—unsuitable food, toxins produced by the organisms themselves or by their cultural companions, etc.—and is not due to any inherent inability to live or frustrated necessity to conjugate. Woodruff's conclusion concerning *Paramecium* seems equally applicable to all other Ciliates: "It is probable that most, if not all, normal individuals have, under suitable environmental conditions, unlimited power of reproduction without conjugation or artificial stimulation."

Popoff tested R. Hertwig's theory that division is a regulatory reaction to an abnormal mass-relation between nucleus and cytoplasm. He concluded that the "karyoplasmic tension" or instability determines division. Many other investigations bearing on the influence of environmental conditions on division are summarized.

The species of *Paramecium* consist of an assemblage of distinct races

(Jordans' "little species," Johannsen's "pure lines") which differ *inter se* in size, form and physiological qualities, but are *in se* constant. Within each race individuals differ in size, as a result of peculiarities of growth, nutrition, and environment. But the races all breed true to their mean dimensions. Selection within the pure race is of no effect on the size. Many other investigations bearing on variations and modifications and their hereditary behaviour are dealt with.

The sexual period is then discussed. Assortative mating or the conjugation of like with like has been proved by Pearl in *Paramecium caudatum*, but it does not seem to be general. Many experiments contradict the view of Maupas that there is a "eugamic period" or a period of "karyogamic maturity" in the life-cycle. R. Hertwig's idea that the "hunger divisions" among starved Ciliates correspond to maturation divisions is erroneous, for the Ciliate is a sexual individual and not comparable to a germ-cell. The phenomena in a Ciliate which are comparable with the two meiotic divisions in a metazoon are the micronuclear divisions preceding fertilization. Many suggestions have been made in regard to the conditions inducing conjugation—whether hunger (Maupas), disturbed karyoplasmic ratio (R. Hertwig), changes in the medium (Enriques), plentiful feeding followed by starvation, followed by treatment with salts in medium concentration (Zweibaum), and so on. As to the effects of conjugation, Maupas emphazised karyogamic rejuvenation, Bütschli and Calkins the counteracting of a slowed rate of division and a condition of senility. But R. Hertwig and Jennings have shown that this conclusion is not justified. Statements or implications that conjugation in Infusorians results in increased multiplication or vitality should disappear. Jennings concluded that conjugation results in variation and in biparental inheritance, which sounds like simultaneously producing uniformity and diversity. Dobell takes the paradox to mean that if two similar individuals of the same race conjugate, then the progeny of both will differ from the original race, though the progeny of one will resemble the progeny of the other in whatever respects it differs from the original race. Or, in other terms, a pair of conjugants a_1 and a_2, belonging to a race a, produce after conjugation progeny, forming races b_1 and b_2, differing from a, but resembling one another in both being b. Both the fundamental conclusions reached by Jennings appear to Dobell unproved. Recent researches on interconjugation and cross-conjugation are discussed.

Dobell believes that many of the problems now associated with Ciliates are really dialectic, and do not exist in nature. Many are due to the error of thinking of a Ciliate as a cell, instead of thinking of it as a complete organism. It has been shown beyond all reasonable doubt that under suitable conditions Ciliates are able to live and multiply in their own fashion, for an unlimited time, like all other organisms that are well adapted to their environment. If "immortality" can be predicated of the Ciliates, it can also be predicated of all other organisms in the same sense. It may be stated with considerable confidence, as a concrete proposition, that conjugation in the Ciliates does not result in rejuvenation, no matter whether a literal or metaphorical meaning be attached to the word.

It is safe to prophesy that when the known facts have been doubled or trebled, the ironical statement—which now prefaces so many memoirs on the Ciliates—that "the Protozoa are the simplest organisms in which to study the great problems of biology" will disappear from biological literature. It is vain to seek for simple mechanical factors which "induce conjugation" in Ciliates. "For conjugation is the resultant of many external and internal factors—environmental opportunities, inherent inclinations and potencies—which are no less complex and no more easily comprehensible than the factors which result in comparable phenomena in man. They are really less easy to understand, because we have no conception of what the 'motives' may be which actuate a brainless, non-cellular creature."

No new light has been thrown upon the great problems of organic evolution by a study of the Ciliates. Nor can we argue from them even to other Protozoa. The Ciliates are so curiously organized that in many ways they stand alone among organisms. What is true of Ciliates is not necessarily, or even probably, true of most other organisms.

Rat Trypanosomes in relation to the Rat-flea.*—J. D. Thomson and the late E. A. Minchin investigated the rat trypanosome (*Trypanosoma lewisi*), and its relation to the rat-flea, *Ceratophyllus fasciatus*. Fifty fleas were secured from rats trapped in the open, and were allowed to multiply in two cages, in one of which was a "clean" and in the other an infected rat to serve as food. The whole stock of fleas was free from any natural infection with leptomonads or other flagellate parasites, and thus a fertile source of confusion and error was avoided. A full account of the structure of the flea is not given, but points of interest are noted in connexion with the structure of the nervous system, the reproductive system, and the heart. The histological structure of the stomach is described in detail. The rest of the first part of the paper is devoted to summaries in tabular form of the results of the different feedings, and an account of the technique employed in dissection.

The second part of the paper deals with the development of *Trypanosoma lewisi* within the flea. During the whole course of development it is confined to the alimentary canal proper, and is found in the stomach, intestine, and rectum, never in the general cavity of the body or in the salivary glands. Exceptionally, however, it may occur in the malpighian tubules. A stomach phase and a rectal phase can be distinguished. The stomach phase lasts from twenty-four hours to four or even five days, and is probably always put a stop to by the second feed, that is, the next after the one by which the flea was infected. This phase is characterized by a peculiar mode of multiplication, the trypanosomes penetrating into the epithelial cells lining the stomach, and there reproducing by a process of multiple fission. The trypanosomes seen in the intestine are active migratory forms on their way to the rectum, where the next phase begins. Occasionally, individuals in the rectal phase are found attached to the walls of the intestine near the pyloric opening, having probably migrated thither from the rectum.

* Quart. Journ. Micr. Sci., lx. (1915) pp. 463-692 (10 pls. and 24 figs.).

The rectal phase consists chiefly of small, often minute individuals, which are crithidial in structure, and are attached by the tip of the flagellum to the wall of the rectum, where they keep up a continual multiplication by binary fission. This phase probably endures as long as the flea lives, and thus it may remain infective without any renewal of the infection. From this crithidial phase arise, by modification of individual forms, the small trypanosome-forms by which infection of the rat is brought about, and which are the final forms of the developmental cycle in the flea. It is interesting, however, that only a small proportion of fleas fed on infected rats become infective. Trypanosomes may be found in the gut of all fleas examined soon after feeding, but in about 75 p.c. the parasites die out without completing the developmental cycle. It is therefore necessary to distinguish a series of degenerative forms from the developmental series. To this section of the paper are appended (1) a history of previous investigations on the development of *Trypanosoma lewisi*, and (2) a note on the possibility of the occurrence of sexual phenomena in *T. lewisi*.

The final section of the paper describes the experimental study of the problems of transmission and development, with the following results. The rat trypanosome (*T. lewisi*) is transmitted from rat to rat by the rat-flea *Ceratophyllus fasciatus*. The transmission takes place by the cyclical method; transmission by the direct method has not been proved to occur. The trypanosomes make their appearance in the blood of the rat five to seven days after infection; the multiplication of the trypanosomes in the blood of the rat comes to an end eleven to thirteen days after infection. The cycle of development in the flea requires a minimum of five days for its completion Transmission is never effected until the developmental cycle is completed, that is, until at least five days after the first exposure of the fleas to infection. The developmental forms of trypanosome in the flea are not infective when inoculated into the rat during a period extending from a short time (half-an-hour ?) after being taken up by the flea until after the development is complete. The rat may become infected by eating infected fleas, but not until the developmental cycle of the parasite within the flea is complete. Infection of the rat is effected contaminatively by way of the rat's mouth, by the rat licking from its fur or skin the moist fœces of fleas containing the final propagative form of the cycle. There is no evidence that the flea can infect the rat by inoculating trypanosomes into it through the proboscis. There is no evidence that hereditary transmission of trypanosomes from flea to flea ever takes place. The trypanosomes in the blood of the rat can render fleas infective soon after they make their appearance in the blood, before their multiplication period is over. Starvation of the flea during the incubation period does not inhibit, or even necessarily retard the developmental cycle of the trypanosome in the flea, but varying food conditions do have some influence on the location and incidence of the Haptomonad phase in the flea's gut.

BOTANY.

GENERAL,

Including the Anatomy and Physiology of Seed Plants.

Cytology,

Including Cell-contents.

Chromosomes and Heredity.*—E. M. East publishes a paper dealing with the chromosome view of heredity and its relation to the practical problems of plant-breeding. After discussing the evidence favouring the physiological and morphological individuality of the chromosomes and the Mendelian theory of inheritance, the author proceeds to examine the results of work bearing upon (1) the relation of chromosomes to somatic characters; (2) the relation between the normal behaviour of chromosomes and the transmission of character; (3) the relation between the peculiar behaviour of the chromosomes and the transmission of character. It is shown that while the behaviour of certain plants and animals favours the view that internal somatic characters, e.g. size of cell, vary directly with the number of chromosomes, the characters of others are quite contrary to it. The evidence bearing upon external characters is equally contradictory; although apogamy is usually accompanied by doubling of the number of chromosomes, the phenomenon itself is due to some more obscure cause: there is no proof that the characteristic external features of either species or genera have any direct connexion with the number of chromosomes. It appears probable that the chromosomes of the higher animals and plants are of greater complexity, although less numerous, than in lower forms, so that alteration in determinants may occur in proportion to the mass of chromatin, without visible variability in the same ratio. The maximum difficulty in the improvement of animals and plants by hybridization is usually directly dependent upon the number of chromosomes, and this difficulty is increased by the greater complexity of the chromosomes. The author's experiments show that the chromosomes of tobacco are more complex than those of wheat, and those of the latter are more complex than those of peas and beans. Practical breeding experiments confirm this ratio in the difficulty of improvement of the four genera. Finally, the author shows that anomalous behaviour in heredity is associated with peculiar chromosome mechanism.

Structure and Development.

Vegetative.

Ray-pits of Conifers.†—F. B. H. Brown has examined the medullary rays of *Picea* and *Larix* in order to discover if there is variation in struc-

* Amer. Nat., xlix. (1915) pp. 457–94 (5 figs.).
† Ohio Nat., xv. (1915) pp. 542–50 (6 figs.).

ture corresponding to variation in conditions of growth. At the margins of the rays are tracheids communicating with the adjacent xylem-tracheids by means of bordered pits. The main part of the ray is composed of parenchyma cells, with semi-bordered pits on their lateral walls and simple pits on their end walls. These cells serve for the conduction and storage of the products of assimilation. More complex rays have a third kind of tissue for the secretion, conduction, and storage of resin. The rays have direct communication with the phlœm and cambium on the one hand, and the xylem-tracheids on the other, and probably continue their activity as long as the wood performs its physiological functions. The pits formed where the storage-cells are in contact with the xylem-tracheids show variations related to the life-conditions of the species. In *Larix* the entire foliage is deciduous each year, so that there is a great demand upon storage-tissue such as is found in the medullary rays. In *Picea* the leaves persist from four to seven years, so that there is little, if any, demand upon the storage-tissues. Corresponding to this difference, it is found that while *Picea* has little or no starch in its woody tissues, the ray-tissues of *Larix* are rich in starch; this is forced into the tracheids and conveyed to new shoots at the beginning of each new season. The annual occurrence of this temporary current is accompanied by a well-defined increase in the size of the immature, semi-bordered pits, "corresponding to the probable time, intensity and duration of the demand" made upon the reserve stores. The structure of the medullary rays of *Picea* is in all respects similar to that of *Larix*, but there is no variation in the size of the semi-bordered pits, so that it would appear that the variation in *Larix* is entirely due to a difference in the conditions of growth.

Reproductive.

Male Flower of Williamsonia.*—H. H. Thomas publishes an account of the male flower of *Williamsonia gigas*. The specimen described belongs to the Yates Collection in Paris, but was found in the neighbourhood of Whitby. It is urn-shaped, and appears to have been composed of eighteen to twenty microsporophylls 7–8 mm. wide, united below to form a cup-like structure 5–6 cm. wide, with a distinct rim round the edge. The base of the cup tapers considerably to what is apparently a stalk about 1 cm. thick. Down the centre of each sporophyll is a series of reniform or elliptical depressions: the upper portions are indistinct, but appear to have tapered up for about 2–3 cm., and there are indications that branches were given off towards the centre of the flower. The synangia seem to have resembled those of *W. spectabilis*. The classification of the specimen presents little difficulty. There is no doubt as to its generic position, and while no direct evidence is available as to its species, several considerations, especially the fact that it comes from a bed containing stems, leaves and female flowers of *W. gigas*, point to its being the hitherto unknown male flower of this species. The position and mode of growth are homologous with those of *W. specta-*

* Proc. Camb. Phil. Soc., xviii. 3 (1915) pp. 105–10 (1 pl. and 3 figs.)

bilis, and the author favours the view that it was a separate unisexual flower, independent of the female strobilus, both flowers having been reduced from a primitive bisexual flower.

Physiology of Pollen.*—Y. Tokugawa publishes a paper dealing with the physiology of pollen in special relation to the sterility of plants towards pollen of another species. Experiments have been made upon numerous species of Dicotyledons and Monocotyledons with the following results. For germination a certain amount of moisture is necessary, and in some species a special stimulating agent must also be present. For growth of the pollen-tube suitable osmotic pressure and food-materials are indispensable, although a certain amount of growth may take place in the absence of external food-material at the expense of the reserve material of the pollen itself. Different species of pollen vary in their susceptibility to injury by organic salts, but generally salts of the heavy metals are more injurious than those of the light ones. The duration of life of the pollen-grain is considerably influenced by variation in the amount of moisture present. Albumin and the various forms of sugar are important as means of stimulating the growth of pollen-tubes, each species showing a specific attraction to one or other of these substances. A similar but more marked specific affinity is seen in the food reserves of the pollen-tubes, which consist of either albumin or sugar. The pollen-tubes are drawn into the stylar canal and the micropyle by chemotropic action, but growth along the stylar canal is a mechanical process. The pollen of any species of either a Dicotyledon or a Monocotyledon can germinate, and even attain a certain stage of growth, on the stigma of another species, but even when there is no mechanical hindrance it cannot reach the ovary; this is possibly due to lack of some specific food-material.

Nature of Peloria.†—M. J. Sirks publishes a paper dealing with the nature and cause of peloric flowers. The first two sections of the paper are devoted to a historical and critical summary of previous work done in connexion with this subject, while the three remaining sections give an account of the author's investigations as to:—1. The essential differences between the floral development of normal and of peloric races of *Antirrhinum*. 2. The connexion between the anatomy of peloric and of normal floral shoots. 3. The indication of gamogemmy in peloric flowers of *Linaria*. It is shown that the development of the zygomorphic flowers of *Antirrhinum* differs from that of normally peloric flowers: the latter may be so modified by such secondary phenomena as fascination, as to be apparently the result of gamogemmy; but the venation of both the zygomorphic and peloric flowers follows the same scheme, so that there can be no question of gamogemmy. Anatomical investigation proves that the course of the bundles of peloric flowers may vary when fasciation occurs. The investigations dealing with *Linaria* were not sufficiently conclusive, but pointed to the same results. The author concludes that peloria is a

* Journ. Coll. Sci. Tokyo, xxxv. No. 8 (1914) pp. 1–53 (2 figs.).
† Arch. Néerland. Sci. Exact. and Nat., Ser. 3, B. ii. (1915) pp. 239–83 (3 figs.).

phenomenon entirely independent of exterior circumstances, and in *Antirrhinum* is a Mendelian character recessive to the normal. Both the peloric and zygomorphic flowers of *Antirrhinum*, and the peloric isomerous flowers of *Linaria*, are isologous and independent of gamogemmy. The fundamental cause of difference in development has not yet been discovered, but is probably to be found in that theory according to which the development of the organs depends upon the presence of some special chemical compound in the tissues of the plant.

General.

Modification by Crossing.*—R. R. Gates publishes the results of some experiments made with the purpose of ascertaining the extent to which it is possible to modify the characters of plants by crossing. In hybrids produced by crossing *Œnothera rubricalyx* and *Œ. grandiflora* the characters of the foliage form a continuous series in which blending and fractionation of character is the rule. The pigmentation of the flower of *Œ. rubricalyx*, being the result of a dominant unit-character, affords important evidence, and it is found that "plants which are intermediate in pigmentation breed true, . . . and that the degree of pigmentation in the parent is adhered to in the offspring."

In back-crosses of these hybrids with *Œ. rubricalyx* the pigmentation is much intensified, and with *Œ. grandiflora* much diluted. The author thinks that this may be explained by assuming that the "grandiflora" chromosomes may "exert a mass-effect in inhibiting the influence of the R chromosome," i.e. the chromosome to whose influence the red colouration is due. In any case there is no doubt that the R character is permanently diluted by crossing with the "grandiflora" type, and as the dilution increases, the pigmentation becomes discontinuous and appears in spots or patches.

CRYPTOGAMS.

Pteridophyta.

(By A. Gepp, M.A. F.L.S.)

Secretory Tissues of Marattiaceæ.†—C. West, writing on the structure and development of the secretory tissues of the Marattiaceæ, says that lysigenous mucilage-canals were found in every genus and species of Marattiaceæ examined. They are usually protogenetic, but occasionally hysterogenetic (e.g. petiole of *Kaulfussia æsculifolia* and root of *Angiopteris erecta*). In the petiole of *A. erecta* the mucilage-canals may be lysigenous or schizo-lysigenous. Tannin-cells are widely distributed through the sporophytic tissues of the Marattiaceæ; they occur either as isolated tannin-sacs, or grouped together in regular or irregular series. Lysigenous tannin-ducts are formed by the solution of the septa between adjacent tannin-cells.

* Amer. Nat., xlix. (1915) pp. 562–9.
† Ann. Bot., xxix. (1915) pp. 409–22 (1 pl. and figs.).

Phyllitis hybrida.*—V. Vouk discusses the ecology of *Phyllitis hybrida*, which is not, as Morton considers, a typical shade- and damp-loving plant, but a mesophyte with distinctly developed xerophytic adaptations. Pevalek and the author found this species, which is endemic on the southern Quarnero Islands, growing in masses on rocks exposed to the sun, and in winter to the direct Bora on the north-east coast of the island of Pago. The specimens were small and compressed, with a coriaceous frond, and covered on the lower surface with scales. The plants which had penetrated deeper into the rock clefts were larger and less coriaceous. But those were only shade forms, never damp-loving forms. It is difficult to say which of the two forms, light or shade, is the original. On the same rocks grow specimens of *Phillyrea* and *Paliurus* deformed by the wind. Other forms grow in the rock crevices.

Pteridophyta of New Caledonia.† — Roland Bonaparte gives an account of the Filicales (ninety species) and Lycopodiales (eight species) collected by F. Sarasin and J. Roux in New Caledonia and the Loyalty Islands in 1911–12, including one new variety. H. Schinz has determined the only *Equisetum* contained in the collection; and G. Hieronymus records four species of *Selaginella*, all collected in New Caledonia, and adds some critical notes upon their affinities.

Bryophyta.

(By A. Gepp.)

Spermatogenesis in Mnium.‡—W. L. Woodburn gives an account of spermatogenesis in *Mnium affine* var. *ciliare*, with the following summary:—1. Resting stages of the spermatogenous tissue show the usual disposition of chromatin and cytoplasm. There is a very prominent, densely staining nucleolus, separated from a surrounding chromatin network by a clear area. The cytoplasm may be evenly and smoothly granular, or slightly flocculent. 2. As the nucleus enters the prophase of division the nucleolus stains more faintly, while immediately outside of the surrounding clear region the chromatin aggregates more densely. A coarse reticulum is formed which passes over into a clearly defined spireme. From the latter six chromosomes are differentiated. 3. So far as observed, the nuclear division proceeds in the usual manner without the accompaniment of polar bodies or plates. 4. The cell-plate seems to be formed in the usual way through cytoplasmic activity in the equatorial region of the spindle; and the daughter-nuclei are reorganized by passing through stages corresponding to those of the prophase, but in the reverse order. 5. No diagonal division was found to occur in either *Mnium* or *Polytrichum*. This makes it rather difficult to

* Oesterr. Bot. Zeitschr., lxv. (1915) pp. 41–3. See also Bot. Centralbl. cxxix. (1915) p. 261.

† F. Sarasin and J. Roux, Nova Caledonia Botanique. I. Wiesbaden: Kreidel, 1914, pp. 35–65 (3 pls.).

‡ Ann. Bot., xxix. (1915) pp. 441–56 (1 pl.).

identify the last division of the spermatogenous tissue until it is completed. 6. The first indications that this division is completed, and that the androcytes have been formed, is found in the separation and rounding off from each other of the cells. Next, the blepharoplast appears in the cytoplasm apparently as a cytoplasmic differentiation in the androcyte in which it functions. 7. The blepharoplast develops as a more or less radially flattened band in a course closely applied to the plasma membrane. The nucleus becomes closely applied to the blepharoplast, loses its coarse network and stains homogeneously, and lengthens parallel with and very closely applied to the blepharoplast. The development of the blepharoplast precedes that of the nucleus. The nucleus and cytoplasm during this process may not be kept entirely separate, but there are indications of a certain amount of diffusion from one to the other. 8. As the blepharoplast and nucleus lengthen to form the mature sperm, they fuse more closely and eventually become indistinguishable, forming a homogeneous band or cord which in cross-section may be elliptical and densely granular, or more nearly circular and hollow, showing the structure to be, at certain stages of its development, tubular throughout part of its length. 9. A vesicle, enclosed within the coiled body of the sperm and containing cytoplasm and probably some nuclear material, disappears as the sperm approaches maturity. The granular substance of the vesicle is apparently used up in the process of development, possibly being directly absorbed through the inner surface of the main portion of the sperm. 10. The mature sperm is long and slender, almost filiform, pointed at both ends, with two cilia attached at the forward extremity of the blepharoplast.

Sex Determination in Mnium hornum.*—M. Wilson discusses the question of sex determination in *Mnium hornum*. He describes an axis of this species which bears normal antheridia, bisexual organs, and modified archegonia. The structure of these is figured. The spermatogenetic cells of the normal antheridia possess six chromosomes, and since this is the normal gametophytic number, the plant in question cannot have been produced aposporously. The author discusses the results obtained by El. and Em. Marchal, and suggests that sex determination is not bound up with meiosis. but is brought about by metabolic processes which operate in the organism over a considerable part of its life-history.

Flattened Protonema of Tetraphis.†—W. J. Hodgetts discusses the vegetative production of a flattened protonema in *Tetraphis pellucida.* Thalloid or flattened protonemata occur in *Sphagnum*, *Andreæa*, *Tetraphis*, *Tetrodontium*, *Buxbaumia*, *Diphyscium*. But none of these mosses (except *Sphagnum*) have been recorded as producing a protonema vegetatively as many other mosses do. The author has, however, in the case of *Tetraphis* growing under natural conditions, observed the vegetative production of large flattened protonemata. They were found in the leaf axils of stems which, being decapitated, were precluded from

* Ann. Bot., xxix. (1915) pp. 433–40 (1 pl.).
† New Phytologist, xiv. (1915) pp. 43–9 (fig.).

producing the normal terminal group of gemmæ. Similar thalloid protonemata are normally developed from the germinating gemmæ and spores of *Tetraphis*.

Gametophyte of Pellia epiphylla.*—A. H. Hutchinson has investigated the varying methods of growth of *Pellia epiphylla*. He finds that the development of the antheridium varies. The dominant method is that characteristic of Jungermanniales; forms occur, not infrequently, which are like the antheridium of Marchantiales, while others are like the archegonium in their early development. The archegonia are produced from cells of the apical group and occur in an archegonial pocket. The diversities from the regular form are few; the large number of neck canal cells, the extreme development of the cap, the frequent reduction of the number of tiers of neck-wall cells to five, and the somewhat massive venter should be noted. The outer cell of the two resulting from the division of the archegonial initial divides horizontally before the vertical wall is formed. As to methods of growth, several periods of growth may be recognized, each having a specific method of growth: the massive; the period of the cuneate apical cell extending until antheridium-formation; the period of regional apical growth, or the period of archegonium-production; and the second period of massive growth, or the period of sporophyte dependence.

Ephemeropsis tjibodensis.†—I. Györffy has studied the histology of certain interesting exotic mosses and describes his results in respect of *Ephemeropsis tjibodensis* Goebel, collected by M. Fleischer in Tjibodas. The capsules of the material examined were all found to be much longer than those figured by Fleischer. On the neck were irregularities and swellings, making the neck nodulose. The epidermis cells at the base of the operculum are flattened; those on the upper part of the operculum are higher than broad. The epidermal cells of the theca in quite young capsules are all bulging; the cell-walls of the epidermis in the young capsule are quite thin. Only portions of the cell-wall which run horizontally show thickenings, while the vertical walls remain thin. As regards the structure of the peristome teeth, the author finds that the cells of the outer layer (plaque extérieure) show lamellated, very marked thickenings—a distinct structure—while the cells of the inner layer (plaque intérieure) are homogeneous, although strongly thickened. Finally, the author describes in detail the stomata and breathing pores, and writes: "The guard cells of the stomata lie at the same level as the neighbouring epidermis cells of the pores; consequently they are doubtless phaneroporous. . . . Thus the capsule of *Ephemeropsis* shows a very advanced development, that is a remarkable degree of adaptation to aerial life, which is indicated most clearly by the stomata. . . . The air-chamber of the neck of the capsule of *Ephemeropsis* is lightly interwoven with the loose cells of the spongy parenchyma. Since, however,

* Bot. Gaz., lx. (1915) pp. 134–43 (4 pls.).

† Ann. Jard. Bot. Buitenzorg. xiv. (1915) pp. 36–51. See also Bot. Centralbl., cxxix. (1915) pp. 153–4.

the intercellular spaces are very large, this internal arrangement proves that the aerobic generation must develop an extraordinary degree of transpiration, which indeed is seen in the stomata."

Scapania paludicola.*—L. Loeske writes on the question of parallel forms in mosses. He has observed that two different species produce parallel forms under similar conditions of life. These two species are *Scapania undulata* and *S. irrigua*, and the respective parallel forms are var. *paludosa* C. Müll. and var. nova *paludicola* L. Loeske. These two forms may be distinguished by the always evenly thickened cell-walls of the leaf of *S. undulata*, and the always triangular cell-thickenings of *S. irrigua*. These differences are hereditary. Both parallel forms show the same feeble growth, pale-green colour, the same markedly crumpled arc-shaped commissure, and live in elevated swamps. What is the origin of parallel forms of such great similarity? Two conditions are necessary: the respective species must be closely allied, and must have similar conditions of life. Further, they must be very variable species and easily influenced by water. Both these considerations play a great part. If *S. irrigua* had not the fixed hereditary character of forming triangularly thickened cell-angles, even in the most difficult conditions of life, it would often be impossible to separate *S. paludosa* from *S. Mülleri*. In *Philonotis* one can often only guess at the relationship of a water-form. *S. paludicola* is perhaps only a form in the making. It may be that the rank of a species is due to it, in the C. Müller sense, as is the case with *S. paludosa* C. Müll. The author found his new "species" in the Upper Hartz, and it is also known to him from the Algäu and Pommerania. A large part of the northern *Martinellia paludosa* as defined by Arnell belongs to *Scapania paludicola*, not to *S. paludosa*.

Sphagnum modified by Cold Water.†—E. Melin continues his studies on the biology of *Sphagnum*, describing in his second paper some cold-water forms of the genus, found in Angermanland. They were varieties of *S. riparium*. The older branches were bare and stiff, while their axes had become green and taken over the function of the fallen leaves. The leaves die gradually from their apex, dropping off bit by bit, beginning at the base of the branches. The stiffness of the axes is caused by a strong cellulose thickening of the cell-walls in the outer portion of the central cylinder. The main stem becomes also very green and functions as assimilative tissue. These cold-water forms grew in and immediately in front of a spring, of which the maximum temperature did not exceed + 6° C. In a higher temperature normal plants were formed. The author attributes the peculiarity of form to the low temperature of the water during the period of vegetation. Similar forms of *S. angustifolium*, *S. apiculatum*, *S. Girgensohnii* and *S. squarrosum* were found under similar conditions of temperature.

* Magyar Bot. Lapok., xiii. (1914) pp. 298–302. See also Bot. Centralbl., cxxix. (1915) p. 259.

† Svensk. Bot. Tidskr., viii. (1914) pp. 309–14 (3 figs.). See also Bot. Centralbl., cxxix. (1915) p. 88.

Pleurozygodon sibiricum a Molendoa.*—I. Györffy writes a short note to point out that *Pleurozygodon sibiricum* Arnell is in reality a form of *Molendoa Sendtneriana*, and corresponds with a new form, f. *dura*, which Györffy is about to publish in his forthcoming monograph of the Molendoæ. To establish priority he here publishes the identity, referring to Arnell's full diagnosis of *M. Sendtneriana*, and promising further details later. His reasons for claiming the species as a *Molendoa* are as follows:—1. Many female inflorescences occur along the stem and not at the apex only. 2. The leaves are those of a *Molendoa* and correspond with the author's f. *dura*. They are remarkably close and much smaller than in other known forms. 3. Leaf cells elongated in the lower portion along the nerve, 3–4-angled in the middle and broader rather than long, and except in the lower portion covered with weak papillæ. 4. Apex formed by the midrib. 5. Structure of the midrib is that of *M. Sendtneriana*. 6. Transverse section of stem is a rounded triangle with central strand; epidermis 1–2 rows of cells.

Forms of Leucobryum glaucum.†—L. Ljubitzkaja publishes a detailed account of the forms of *Leucobryum glaucum*. He maintains that in Europe we have but this one species of the genus. *L. albidum* is but a variety of it. In the Caucasus and in Italy occurs a new variety here described under the name of *gracile*. The author discusses the free flattened balls or disks of *L. glaucum* which occur in Britain, and have been described by Burrell and Williams; he has found them also in the Russian province of Minsk, leading a similar detached life; and he calls them var. *subsecundum*. In Western Russia *L. glaucum* is abundant but sterile; rare in central Russia, and absent further east; but it is abundant and fertile in the Caucasus—var. *gracile*.

Microscopical Methods in Bryological Work.‡—G. T. Harris publishes some instructions as to the best methods of preparing a permanent series of mounted slides of mosses for microscopical study of their structure, with suggestions as to the selection and treatment of the parts of the plant which should be mounted, and hints for the avoidance of difficulties and failures in the preparation and preservation of the mounts. In the light of years of experience, he discusses the most suitable mounting media, cements, etc.

New Mosses from West Ross-shire.§—J. Stirton describes some new mosses from Duncraig in West Ross-shire. *Limneria viridula* is a new genus and species which shows some affinity with both *Rhacomitrium* and *Campylostelium*. *Bryum intortulum* and *Campylopus obtectus* are barren species previously unknown. *Leptodontium Rossii* is also a barren new species. Four other species of *Leptodontium* occur in the same neighbourhood, one of which—*L. terrenum*—was described by him in 1900. And only one of them—*L. flexifolium*—is known in the fertile

* Arkiv f. Botanik, xiv. No. 1 (1915) 3 pp. (1 pl.).

† Bull. Jard. Impér. Bot. Pétrograd, xiv. (1914) pp. 351–419 (figs. and map). See also Bot. Centralbl., cxxix. (1915) p. 230.

‡ Journ. Quekett Micr. Club, xii. (1915) pp. 521–36.

§ Trans. Proc. Bot. Soc. Edinburgh, xxvi. pt. 4 (1915) pp. 423–9.

state. *L. gemmascens*, for reasons of structure, leaf-shape, and habitat, he would exclude from the group.

Census of Irish Mosses.*—H. W. Lett publishes a census report on the mosses of Ireland. He records under each species the provinces in which it has been found, adding the actual locality, date, collector's name, and a reference to the publication or herbarium upon which the record is founded. The provinces adopted are those defined by J. Ll. Praeger. The census is preceded by a report on the progress of bryology in Ireland, in which short biographical notices of the collectors of, and writers on, Irish mosses are given. A bibliography is supplied, and a list of the 118 species and varieties added to the flora since the publication of David Moore's Synopsis (1872).

Mosses of Jämtland.†—H. Persson has examined bryologically the alpine regions of south-west Jämtland and north-west Härjedalen, and publishes here a list of his collections. The total number recorded is 243 species, of which 162 are acrocarpous and 81 are pleurocarpous. *Andreæa Thedenii*, *Bryum comense*, and *B. jemtlandicum* are new to Sweden. The last species is new to science, and is allied to *B. microstegium*, *B. misandrum* and *B. sarekense*. The points of difference are set forth. Three new varieties are described, and special attention is paid to *Andreæa Thedenii*. The author was fortunate enough to find the hitherto unknown fruit of *Astrophyllum hymenophylloides*. The structure of the peristome shows that the species belongs to *Astrophyllum* (= *Mnium*), and not to *Cinclidium*, as has been suggested. The author criticizes the view that *A. hymenophylloides* is identical with *C. hymenophyllum*, but agrees to place the latter species in the genus *Astrophyllum*. The paper includes tables showing the distribution of the larger genera in different regions, the fertility of the species, their origin, etc.

Hepaticæ from Hungary and Croatia.‡—V. Schiffner writes on the Hepaticæ of Hungary and the Hohe Tatra, and records several species new to the regions. A species which he had previously determined as *Marsupella emarginata* Dum., from the neighbourhood of the Grüner See in the Tatra, should rather be placed in *M. Pearsonii*. The leaf-margins are very strongly incurved. The larger forms resemble more or less *M. aquatica*.

North American Hepaticæ.§—A. W. Evans publishes further notes on New England Hepaticæ. In Article No. 11 he treats of *Clevea hyalina*, *Neesiella rupestris*, *Lophozia grandiretis*, *L. quinquedentata*, *Plagiochila Austini* (formerly regarded as identical with the European *P. spinulosa* Dum.), *Cephalozia media*, *Diplophyllum gymnostomophilum*, and discusses their structural characteristics and their affinities in some detail.

* Proc. Roy. Irish Acad., xxxii. Sect. B, No. 7 (1915) pp. 65-166.

† Arkiv f. Botanik, xiv. No. 3 (1915) 70 pp. (figs.).

‡ Magyar Bot. Lapok., xiii. (1914) pp. 302-9. See also Bot. Centralbl., cxxxi. (1915) p. 260.

§ Rhodora, xvi. (1914) pp. 62-76.

In Article No. 12 he treats * in like critical fashion of *Fossombronia cristula*, *Lophocolea alata*, *Cephalozia catenulata*, *C. macrostachya*, *Cephaloziella spinicaulis*, *Calypogeia paludosa*.

The same author † publishes a preliminary list of forty-one Colorado Hepaticæ, representing an addition of twenty-three species to the flora.

Mosses of West Coast of South America.‡—R. S. Williams publishes a list of mosses collected by J. N. and Mrs. Rose in Peru, Bolivia and Chile in 1914. Several of the forty-one species are of interest, being from the dry cactus region of the west coast of South America. Ten species are described as new to science; and two of these belong to a new genus, *Pseudocrossidium*, the leaves of which are remarkably revolute above—even twice revolute in *P. apiculatum*. Figures illustrating the structure of the new species are supplied.

Bryophyta of New Caledonia.§—I. Thériot reports on the mosses collected in New Caledonia and the Loyalty Islands by F. Sarasin and J. Roux in 1911–12. He records forty-two species, two of which are new to science—*Macromitrium Sarasini* (from New Caledonia) and *Isopterygium Sarasini* (from Loyalty Islands). Descriptions of these are given.

F. Stephani ‖ has determined the Hepatics of the same expedition: two in number, *Aneura viridissima* and *Acolea caledonica*, the latter a new species.

Thallophyta.

Algæ.

(By Mrs. E. S. Gepp.)

Glaucocystis nostochinearum.¶—B. Millard Griffiths describes the structure of *Glaucocystis nostochinearum* Itzigs., a unicellular solitary alga found in *Sphagnum* bogs. It is ellipsoidal, 30–45μ long by 18–25μ wide, with a small polar thickening within each end, and an equatorial external thickening. The cell-wall is mainly of cellulose. The chromoplast consists of strongly recurved and radiating blue-green bands, which break up during cell-division. Two, four or eight daughter-cells are produced within the mother-cell. During the resting stage the nucleus is "open," a spherical mass of delicate reticulate protoplasm which does not take stains. It is distinguished from the general cytoplasm by containing no metachromatin granules. It lies close against the cell-wall. During the division stage the nucleus contracts, becomes coarsely reticulate, moves to the centre of the cell, and becomes stainable. Chromatin

* Rhodora, xvii. (1915) pp. 107–20.
† Bryologist, xviii. (1915) pp. 41–7.
‡ Bull. Torrey Bot. Club, xlii. (1915) pp. 393–404 (5 pls.).
§ F. Sarasin and J. Roux, Nova Caledonia. Botanique. I. Wiesbaden: Kreidel, 1914, pp. 23–32.
‖ F. Sarasin and J. Roux, Nova Caledonia. Botanique. I. Wiesbaden: Kreidel, 1914, p. 19.
¶ Ann. Bot., xxix. (1915) pp. 423–32 (1 pl.).

develops in it; and a nuclear membrane forms. The metachromatin granules of the cytoplasm disappear. The chromatin of the nucleus aggregates into a large karyosoma. This divides by transverse fission; so, too, does the cytoplasm; the halves round off, and daughter-cell walls are formed.

Glaucocystis probably belongs to the Cyanophyceæ, because of the "open" nucleus, the tendency of cytoplasmic division to take place independently of nuclear division, and the presence of phycocyanin in the chromoplast. The very high differentiation of the nucleus in the dividing stage, the elaborate chromoplast to which the phycocyanin is confined, the formation of daughter-cells like those of *Oocystis*, and the cellulose wall, are features that separate *Glaucocystis* from all other Cyanophyceæ, and probably justify the placing of this genus in a special group of Cyanophyceæ.

Pleodorina illinoiensis in Britain.*—W. B. Grove gives a detailed account of the structure, movements and life-history of *Pleodorina illinoiensis*, an American alga which he collected in quantity in cart-ruts at Harborne near Birmingham, and kept under observation. He compares it with *Eudorina* and *Pandorina*, and finds the distinction drawn between *Eudorina* and *Pleodorina* to be a somewhat slender one, so far as it relates to the difference in shape of the colonies and in size among the cells in the same colony. *Pleodorina* is an advance on *Eudorina* in the direction of *Volvox*, where the distinction between somatic and reproductive cells is strongly accentuated.

Plankton of the Mansfeld Lake.†—F. V. Coditz writes on the biology of the Mansfeld Lake with special reference to the centrifugal plankton and its relation to the net-plankton of the pelagic zone. The lake lies in Saxony and is the largest inland water of Middle Germany. It was formerly an old river valley. The water is a dirty-green to brown colour. The centrifugalized algæ show a small number of species in consequence of the salinity, but the number of individuals is enormous. In spring the principal food of the net-plankton consists of the developmental stages of *Microcystis æruginosa* Lemm., which were demonstrated for the first time by means of the centrifugal apparatus. *Microcystis* is developed pelagically. The maximum of the centrifugal plankton fell during the spring and autumn circulation of the water. Widely spreading out forms or those with a gelatinous sheath are of no use for food for animal plankton. The water-bloom is encouraged by slightly salt water. The phyto-plankton of this lake differs from that of the hitherto known types of the larger North German waters by the lack of the dominating Bacillarieæ, *Melosira*, *Fragilaria*, *Asterionella*, as well as *Dinobryon*, *Ceratium* and *Peridinium*. *Botryococcus Braunii* is present in spring and autumn plankton. Finally, the author discusses the relations between centrifugal and net-plankton.

* New Phytologist, xiv. (1915) pp. 169–82 (figs.).

† Zeitschr. wiss. Zool., c. (1914) pp. 520–630. See also Bot. Centralbl., cxxix. (1915) p. 250.

Nanno-plankton of the Lake of Zug.*—K. Lantzsch publishes his investigations on the nanno-plankton of the Lake of Zug, and its relation to the zoo-plankton. The nanno-plankton or centrifugal plankton shows in summer and autumn a characteristic distribution in layers. The lower limit at this season is about 80 m. deep. Here are found the following: *Chroococcus*, *Gomphosphæria*, *Cyclotella*. Flagellates (*Chromulina ovalis* most common) appear to be limited to the upper 40–50 m.; they show active photactive migrations. Towards the autumn optimal zones of the components of the nanno-plankton become more marked (*Chroococcus*, *Gomphosphæria*, *Binuclearia*, and *Cyclotella*). The determining factor seems to be the respective transparency and quantity of light. The winter streamings obliterate these strata, and a distribution is found in which there is no marked maximum from the surface to the bottom (0–200 m.). In May there appears again the summer depth-limit of 80 m. At the bottom was found a specific fauna, which is discussed. The author suggests that centrifugal examination might bring out new facts concerning Flagellates, Bacteria, and Ciliates. A new species of Peridinieæ is described.

Plankton of the Adriatic.†—J. Schiller writes on the smallest plankton of the Adriatic, particularly the Coccolithophoridæ. Besides the phyto-plankton, the author found a rich nanno-plankton containing Coccolithophoridæ, Peridinieæ, Silicoflagellatæ, Diatoms, Flagellatæ, Chlorophyceæ. The last three groups are more abundant in the cooler than in the warmer seasons. The Coccolithophoridæ, on the other hand, have the same distribution throughout the year. The Peridinieæ are pronounced warm-water forms. The maximum development occurs in May to June; the minimum in December. It is always in the uppermost strata that the richest development of the smallest plankton occurs. Many species of Coccolithophoridæ are able to withstand high and low temperatures, strong cultivation, even a great fouling, and a high percentage of organic material; even under these conditions they are able to attain luxuriant growth. The Flagellatæ are rich in eleven genera, two being described as new. Many plankton animals live on the Coccolithophoridæ, and they form the most important builders of sediment among the Adriatic organisms.

Biological Conditions of the Adriatic Flora.‡—J. Schiller describes the biological conditions of the flora of the Adriatic. The mud which covers the bottom is not suited for the establishment of algæ. Only along the coasts is there a narrow border of ground covered with pebbles, shells, etc., which bears a rich vegetation. Only in summer is there a greater difference of temperature than 6°–7° between the water of 0–20 m. and below 20 m. Light is the most important factor for the vertical distribution of the vegetation, as in the Gulf of Naples. The

* Zeitschr. wiss. Zool., c. (1914) pp. 631–93 (6 figs.). See also Bot. Centralbl., cxxix. (1915) p. 251.

† Ver. k.k. Zool. Bot. Gesell., lxiv. (1914) pp. 66–7. See also Bot. Centralbl. cxxix. (1915) p. 252.

‡ Ver. Gesell. Deutsch. Natur. u. Aerzte, ii. (1914) pp. 669–700. See also Bot. Centralbl., cxxix. (1915) p. 275.

northern part of the Adriatic (the Gulf of Trieste) shows the poorest number of species. This is caused by the greater inflow of fresh water and the fouling from the harbour of Trieste. For this reason there exists here a foul-water flora with few species but great development. Outside the Gulf in pure water the number of the species increases immediately, and a similar increase takes place at Quarnero where the typical blue water of Dalmatia begins. The greatest depths at which algæ are found is about 140 m., where islands of algæ occur on the barren mud. Summer and winter are deep times for the algæ. They show a more lively growth in spring than in autumn. The biological conditions of the plankton are in many respects parallel to those of the benthos. Both in their rise and fall they are almost in agreement, and in the limits of their distribution. It is possible to establish a vertical stratification of the plankton, even though a number of surface species occur in equal quantity down to 200 m.

Trachelomonas.*—G. I. Playfair publishes an account of the species and varieties found in New South Wales during the past seven years, in the two districts of Sydney and Lismore. The waters there are very rich in forms of the genus, and exhibit a great variety of types. Ground-gatherings out of swampy places were found to be best, those out of weeds less good. One hundred and four species and varieties are recorded, many of them new to science. The author points out that the species are, of course, conventional ones for purposes of classification. Of biological species in *Trachelomonas* he only recognizes two—(1) comprising all the rounded forms, (2) the tailed (stipitate) forms ; and of these two even the latter is of doubtful distinctness. The reproduction and the composition of the lorica are shortly discussed.

German Diatoms.†—F. Hustedt reports on Bacillariales from the Sudetic Mountains and neighbouring regions of the Oder valley. Thirty-nine genera, containing 259 species, are recorded. Critical remarks are made on the various species, and data are given concerning the vertical and horizontal distribution.

Diatoms of Steiermark.‡—W. Bouvier publishes the first account of the diatoms of Steiermark. He deals with the Fragilarioideæ, Achnanthoideæ, Naviculoideæ, and Surirelloideæ. Many forms are described and figured, but no names are given to them, although they are in all probability new. Great plasticity of form was found in *Ceratoneis arcus* Kütz., *Navicula iridis* Ehr., *Pinnularia mesolepta* Ehr., *P. subsolaris* Grun., and *P. viridis* Ehr.

Nuclear Division in Vaucheria.§—L. Kurssanow writes a full account of the nuclear division in *Vaucheria*, the species examined being

* Proc. Linnean Soc. New South Wales, xl. (1915) pp. 1–41 (5 pls. and figs.).
† Arch. Hydrobiol. u. Planktonk., x. (1914) pp. 1–128 (2 pls.) See also Bot. Centralbl., cxxix. (1915) p. 250.
‡ Jahresb. k.k. Staatsgymn. Leoben, xvii. (1915) pp. 3–16 (3 pls.). See also Bot. Centralbl., cxxix. (1915) p. 249.
§ Biol. Zeitschr. Moscow, ii. (1912) pp. 13-27 (1 pl.). See also Bot. Centralbl., cxxix. (1915) p. 133.

V. terrestris, *V. uncinata*, *V. repens*, and a *Vaucheria* sp. The following results were obtained. 1. The resting nuclei vary greatly in size, according to the species. Those of *V. terrestris* have a diameter of 4–4·6 μ; those of *V. racemosa* 2–3 μ. The nucleus has always a distinct membrane, and in the middle is a body resembling a nucleolus. A nuclear skeleton is present, which stains well. 2. The division of the nuclei takes place in waves, so to speak. The separate successive phases are distributed in a certain order along the length of the filament. The first sign of the approaching division is a remarkable increase in the size of the nuclei. The number of the chromosomes is not large. A ring-shaped arrangement of the daughter-chromosomes is often seen. The stage of the telephase has this appearance: two daughter-nuclei, with characteristically distributed chromatin, in the form of a star and with a central opening, are stationed at the poles of the membrane of the mother-nucleus, which is penetrated at the axis by a bundle of connecting filaments. At the moment when the central chromatin ring tears, there appears in the interior of the nucleus a roundish body, which stains very deeply, the nucleolus, which has re-appeared. 3. As to the arrangement of the dividing nuclei, the division of a nucleus is not directly connected with the zone of growth. The origin of the wave-like divisions is the result of a certain disturbance in the simultaneity of the division, and is directly dependent on the speed of development of the cell. Similar cases occur frequently in non-cellular plants, where also isolated divisions take place. Such isolated divisions may possibly be found in *Vaucheria*.

Cytology of Zygnema ericetorum.* — G. S. West and Clara B. Starkey publish a contribution to the cytology and life-history of *Zygnema ericetorum* (Kütz.) Hansg., with some remarks on the genus *Zygogonium*. In each cell of *Z. ericetorum* there is normally only one large axile chloroplast, of indefinite outline. It is usually constricted in the middle, and in some cases twisted. There are two large pyrenoids, one in each half of the chloroplast. The latter usually is more or less masked by numerous oil-globules. A low temperature causes the cell-wall to thicken and cysts to be produced. Filaments of the aquatic form grow well in a 0·2 p.c. Knop's solution. Filaments of the terrestrial form, when placed in water, gradually fragment and become dissociated into short lengths of cells, which, however, may ultimately grow into long filaments. If placed in 0·1 p.c. Knop's solution, similar fragmentation occurs, but is longer delayed. When allowed to dry gradually, the filaments fragment into thick-walled "cysts."

The genus *Zygogonium* as founded by Kützing (1843) is untenable; and available evidence does not support the retention of *Zygogonium* on the basis put forward by De Bary (1858) and Wille (1909).

Ægagropila Formations.† — J. E. Ljungqvist describes peculiar modes of growth of *Scytonema*, found by him in the Mästermyr bog on the island of Gottland, in the summer of 1896. The species in

* New Phytologist, xiv. (1915) pp. 194–205 (5 figs.).
† Arkiv f. Botanik, xiv. No. 4 (1915) 34 pp. (3 pls.).

question were *S. figuratum* Ag. and *S. myochrous* Ag. They occurred in the following formations:—1. Patches, half-dry, dark brown, about 3 mm. thick, between the cushions of a *Schœnus ferrugineus*-association at the edge of the bog. 2. Cushions on the chalky bottom of the bog-lakes. 3. Tufts epiphytic in strongly encrusted *Chara* vegetation, or lying loose on the bottom of the bog-lakes. 4. Balls, the true *Ægagropila*, developed in only one of the bog-lakes. Of these forms, Nos. 2 to 4 were found in various stages of development in one and the same lake.

Green Algæ of the Adriatic.*—H. Cammerloher publishes a general account of the green algæ recorded from the Adriatic, gathered from his own collections and those at Vienna, Trieste, and Rovigno. He has carefully studied all previous work on the morphology, anatomy, cytology, and development of the algæ dealt with here. The book is principally a review of the literature, but it serves as a good guide to a collector in the Adriatic, particularly on account of the excellent figures included. Seventeen families are treated.

Algæ from the Neighbourhood of Greifswald.†—A. Wilczek reports on the algæ found in the neighbourhood of Greifswald. Schizophyceæ occur everywhere; Oscillatorieæ are the most frequent. In May *Oscillatoria Fröhlichii* f. *fusca* was found singly; in June it covered a ditch with great balls; in the middle of July it had almost disappeared, to reappear at the end of August. Instances are given of the spread of brackish and fresh-water species of diatoms, *Enteromorpha* and *Cladophora*. The last two genera are the most strongly represented, even in fresh water. Desmids occur sometimes between other algæ, but are rare. *Closterium acerosum* Ehr. was, however, found in pure cultures. The author's summary of the vegetation in the individual months shows that up to the end of April diatoms are frequent, and their number in individuals surpasses that of any other alga. In May to June is the maximum. At that time appear the Protococcoideæ. Early in July Chlorophyceæ form the principal mass. Soon afterwards the diatoms appear again in quantity. The beginning of December they disappear entirely. A systematic list of the species recorded is given, as well as tables on the relative frequency of an alga at different localities and in different months.

"Blasen-zellen" of certain Florideæ.‡—H. Kylin discusses what he calls the "Blasen-zellen" of certain Florideæ. These are special, strongly refractive cells, which occur in the Florideæ and have been mentioned by various authors. Those present in *Bonnemaisonia asparagoides*, *Spermothamnion roseolum*, *Ceramium tenuissimum* and *Antithamnion plumula* are here described in detail. In *Bonnemaisonia asparagoides* they vary in size from 5–8 μ, and are filled with a homogeneous, colourless, strongly refractive substance. They are described

* Die Grünalgen der Adria. Berlin: Bornträger, 1914 (6 pls.). See also Bot. Centralbl., cxxix. (1915) pp. 249–50.

† Mitt. Naturw. Verein Neupommern u. Rügen in Greifswald, xliv. (1912) pp. 25–99. See also Bot. Centralbl., cxxix. (1915) pp. 275–6.

‡ Arkiv f. Botanik, xiv. No. 5 (1915) 13 pp. (figs.).

as iridescent by some authors. Kylin finds that albumen plays no part in the cell-contents, but agrees with Molisch that a labile chemical combination is present which easily throws off iodine. When the plant dies, these "Blasen-zellen" burst, the contents come out and the iodine stains blue any starch solution, and leaves a blue mark on paper. The author surmises that the cells act as a protection against small animals, particularly small molluscs which eat algæ. In *Spermothamnion roseolum* almost every cell bears on its upper transverse wall one of these "Blasen-zellen." They vary from 8–10 μ and appear to have the same cell-contents as those of *Bonnemaisonia asparagoides*. In *Ceramium tenuissimum* the "Blasen-zellen" contain an elongated prismatic albumen-crystal, occasionally two or three. The number of these cells in the different cortical rings of a branch varies greatly, sometimes none, sometimes as many as ten being present. In this alga the cells contain albumen-crystals and no iodine. These albumen-crystals probably play some part in the nutrition, possibly during the development of spores, since the "Blasen-zellen" are known to disappear in later stages of the alga. The "Blasen-zellen" of *Antithamnion plumula* have been already described by Nestler. In their upper part one commonly finds several small chromatophores lying embedded in a little protoplasm. The cell-contents are colourless and strongly refractive. Under a weak magnification they appear to be homogeneous; under stronger magnification, however, there is seen a peculiar, finely-granular structure. The contents are albuminous, and no iodine was found. Various authors attribute various functions to these cells. Kylin is unable to make any decided statement, and refrains from adding to the many surmises.

Oceanic Algology.*—A. Mazza continues his studies of marine algæ. He discusses *Blastophye*, a genus of doubtful affinity, with one Australian species; and then begins a review of the family Dumontiaceæ, describing the structure and characteristics of the typical species of *Dumontia* (1 sp.), *Cryptosiphonia* (2), *Dudresnaya* (4).

Kelps of West Coast of America.†—F. K. Cameron publishes a report entitled "Potash from Kelp," in which are included papers by himself and others on the production of potash for agricultural purposes from the large kelp beds in the United States. With few exceptions, the supply of this element has always come from the German mines; but the present report shows that the United States could produce its own supply. Of the large number of algæ growing on the Pacific coast, only three species seem to offer any particular promise of importance as possible commercial sources of potash salts, since, besides having a high potash-content, they grow in open water and can be easily harvested. They are *Macrocystis pyrifera*, *Nereocystis lütkeana*, and *Alaria fistulosa*.

The large kelp beds are reported on by specialists. Those from Lower California to Paget Sound were investigated by W. C. Crandall

* La Nuova Notar., xxvi. (1915) pp. 133–54.

† U.S. Dept. Agric., Report No. 100 (1915) 122 pp. (40 pls. and tables).

those of Puget Sound and of Western Alaska by G. B. Rigg; those of South-east Alaska by T. C. Frye. The structure and life-history of the species in question are considered, with a view to preventing their extermination by an over-free harvesting. A portolio of large coloured maps is issued with the report, to show the distribution of the algæ.

Algæ for Beginners.*—G. Lindau publishes the second volume of his "Cryptogam-flora for Beginners." It treats of the Conjugatæ, Chlorophyceæ, and Characeæ. In the introduction he describes the life-history of the respective groups, their development, reproduction, relationships, etc.; and draws special attention to the gaps in our knowledge of the subject, notably in regard to the lowest forms, thus encouraging further study. The systematic part contains short clear diagnoses of a well-chosen number of species. Critical or very rare species are not described.

The Thalassioscope.†—M. von Leinburg describes a new instrument which allows of an examination of the sea-bottom from the surface. The object can be focused at any distance without altering the range and with the least absorption of light. The apparatus is useful for studying algæ *in situ*.

Fungi.

(By A. Lorrain Smith, F.L.S.)

Zygorhynchus japonicus.‡—K. Kominiani describes this new species of heterogamous Mucorineæ, which he isolated from soil in Japan, and cultivated on a large number of substrata. The mycelium and conidiophores are colourless, while the sporangia are yellowish. The spores are ellipsoid and variable in size. Zygospores are formed abundantly by the copulation of two hyphæ unequal in thickness, which arise by the bifurcation of a filament. The species is homothallic. A diagnosis of the fungus is given, and the points of difference between it and other species of the genus are noted.

Chætomium and Ascotricha.§—F. H. Chivers has published a monograph of these two genera, as a contribution from the Cryptogamic Laboratory of Harvard University. In *Chætomium* he records twenty-eight well-determined species. The genus *Ascotricha* contains two—sometimes listed as *C. chartarum* and *C. pusillum*. The genus differs from *Chætomium* in the form of the perithecium, etc. The writer gives a historical sketch of genera and species and a synoptic key to the species. With the specific diagnoses he gives careful notes as to habitat, and the

* Kryptogamen-flora f. Anfänger, iv. No. 2. Berlin: J. Springer, 1914, xxvi. and 200 pp. 8vo. (437 figs). See also Bot. Centralbl., cxxix. (1915) p. 26.

† Umschau, 1914, pp. 282–90 (2 figs.). See also Bot. Centralbl., cxxix. (1915) p. 252.

‡ Mycol. Centralbl., x. (1914) pp. 1–4 (1 pl.).

§ Torrey Bot. Club, xiv. (1915) pp. 155–240 (12 pls.).

results of culture experiments which he was able to carry out with many of the species. The relation to other published species are also fully discussed. The monograph is copiously illustrated.

Marine Pyrenomycetes.*—G. K. Sutherland supplies additional notes on these fungi. He describes *Orcadia pelvetiana* sp. n., which grows in the tissues of living *Pelvetia canaliculata*. It differs from the previous species discovered by the author on *Ascophyllum nodosum* in the smaller size of the various parts and in its relation to the host, to which it does little damage.

Another new species on the same host, *Didymosphæria pelvetiana*, was found not only in the Orkneys but also in the Solent on sea-borne material. The perithecia are scattered over the host and cause blackening of the algal tissue. Other new species, *D. fucicola* on *Fucus vesiculosus* and *Hypoderma Laminariæ* on *Laminaria saccharina*, were also found in Orkney. The latter is the first member of the Hysterineæ to be recorded from marine algæ.

Pyronema confluens Tul. var. inigneum Brown.†—Cultural studies of this variety have been made by W. H. Brown from a specimen that grew on a flower-pot in the botanical laboratory of Johns Hopkins University. It is like the species except that it does not require sterilized soil (carbonaceous soil) on which to develop. Brown describes the development of the sexual organs, which also show some peculiarities; the antheridia and ascogonia are independent of each other, and in no case was any fusion between the two observed. They retain their normal appearance long after the ascogenous hyphæ have grown from the ascogonia. The only nuclear fusion observed was in the penultimate cell which gives rise to an ascus; the fusion nucleus then goes into synapsis, and at the first and subsequent divisions there are five chromosomes.

Ascomycetes of Ohio.‡—The study of these plants has been undertaken by Bruce Fink and C. Audrey Richards. Lichens have been included as parasites on algæ, and Fink takes special charge of that group. He reviews work done in regard to their life-history—the sexual process and symbiosis. He traces the origin of the group from the Rhodophyceæ, and he places at the end of the series the Perisporiales, Aspergillales, Exoascales and Saccharomycetales as degenerate or doubtful Ascomycetes.

In a second part of the paper he takes up the Collemaceæ of Ohio; he explains his own particular view of lichens and his methods of diagnosing the genera and species, which are fully described later.

Degenerate Form of Aspergillus niger.§—This form occurred in artificial cultures of the fungus by R. Schramm, and was characterized by the absence of normal conidial production, the concentration of the

* New Phytologist, xiv. (1915) pp. 183–93 (3 figs.).
† Amer. Journ. Bot., ii. (1915) pp. 289–97.
‡ Ohio Biol. Survey, Bull. 5, ii. No. 1 (1915) 70 pp. (6 pls.).
§ Mycol. Centralbl., v. (1914) pp. 20–7 (5 figs.).

conidial colour-substance in peculiarly formed mycelial hyphæ, and the formation of yeast-cells which increase by budding. So far the author had been unable to get the culture back to the normal plant, though the most varied culture media were used. The yeast form had fermentation power, a new development for *Aspergillus*.

Penicillium avellaneum sp. n.*—Ch. Thom and G. W. Turesson found in cultures of this species that the ascus-producing form was common; it appeared in almost all of the media used. The cultures tended to become more or less Indian-red. The small conidia were borne on apical verticils with sterigmata. The perithecia had a peridium of thick-walled cells. The ascospores have thick walls, pitted, or with the appearance of round transparent spots.

American Rusts.—C. A. Ludwig † has been studying the *Cæoma* forms of rusts, and he now gives a synoptic key with notes on *Coleosporium* and *Melampsora*. In it he uses the wall of the uredinospore as a distinctive character; he finds that these walls are thickened in various ways, and in some species are verrucose. The teleutospores are not of much use in determining species. In *Melampsora* he makes use of the position of the pycnidia. Careful descriptions of some little-known species follow.

J. R. Weir ‡ describes for the first time the teleutospore stage of *Gymnosporangium tubulatum*. It forms lobed galls on the branches and twigs of *Juniperus scopulorum*. The identification was suggested by the association in place of *Juniperus* with *Cratægus Douglasii*, of which the leaves were being destroyed by an æcidium. Culture experiments have proved the relation between the two forms.

Notes are also published of experiments on *Peridermium pyriforme* by J. E. Kirkwood, § and they have gone far to prove that *Pinus ponderosa* and *Comandra pallida* are the alternate hosts of that fungus. The fungus reacts on the tissues of both hosts in a similar manner, ramifying through the resin ducts and intercellular spaces of the cortex, traversing the medullary rays to the pit, and extending up and down through the tracheids. The author does not claim to have definitely settled the point, as galls have not yet been produced on the inoculated host.

Uredineæ of Porto Rico.‖—J. C. Arthur has described a series of species in continuation of a previous paper. The genera *Uromyces*, *Puccinia*, *Pucciniosira* and the form genus *Æcidium* are all represented in this contribution. *Pucciniosira* is distinguished by the æcidioid peridium of the sori and by the intercalary cells in the catenulate teleutospores. Various descriptive and historical notes are given with each species.

* Mycologia, vii. (1915) pp. 284–7 (3 figs.).
† Phytopath., v. (1915) pp. 273–81.
‡ Phytopath., v. (1915) p. 218.
§ Phytopath., v. (1915) pp. 223–4.
‖ Mycologia, vii. (1915) pp. 227–53.

Distinction between Coniothyrium pirinum and Phyllosticta pirina.*—The latter fungus was discovered and described by Saccardo and the spores given as constantly hyaline. Later, Sheldon found a species of *Coniothyrium*, distinguished by the constantly dark-coloured spores, and insisted that it was a mature stage of the *Phyllosticta*. Elisa Mutto and Gino Pollacci have gone into the subject and have examined specimens of both fungi. They find that there are two distinct species, but that *Coniothyrium pirinum* corresponds with a previously described species *C. tirolense*. Both fungi are parasitic on the leaves of *Pirus communis*.

American Basidiomycetes.†—W. A. Murrill now publishes "Illustrations of Fungi," xxii. The page of coloured figures includes ten different fungi, *Russulæ*, *Cortinarii* and others; most of them are found in Britain as well as in America.

Murrill ‡ also gives an account of the genus *Clitocybe* in America, many of the species being also European. He divides the genus into several, which are distinguished by spore and pileus characters. Most of them have been collected in New York State. Some species are new to science. To all of them are appended notes as to habitat and general appearance.

Synopsis of Polyporus.§—C. G. Lloyd has issued a comprehensive account of the *Apus* section of this genus. He gives a historical account of the species which, at first, were classified as *Boleti*. He then gives an arrangement of the species, with notes of their distinctive characters, history, and distribution. Several divisions are recognized, with hyaline spores and with coloured spores, as also divisions depending on the colour of the pores and the texture of the pileus. These are again divided into sections distinguished by the characters of the pileus. The pamphlet is well illustrated with seventy-six photographic prints.

Woodland Fungi.‖—Carleton Rea gives an account of the plant associations that affect the growth of the larger fungi. Woods are mainly of two kinds, deciduous and coniferous, and the latter are especially favourable to the growth of *Boletus* and of *Hydnum* and species of *Russula*. Oak, beech, and birch woods have each their distinctive fungus flora, though many species are common to all. Fungi that are true parasites are confined to definite trees. There are also certain fungi that are found generally on pastures or lawns, such as the *Hygrophori*, and there is a characteristic flora of burnt places and charcoal heaps. Rea has given descriptive lists of many of the species found in these varying habitats.

Homology of the "Universal Veil" in Agaricus.¶—G. F. Atkinson finds that in *Agaricus arvensis*, *A. campestris*, and *A. comtulus* the

* Atti Reale Accad. Lincei, cccxii. (1915) pp. 40–2.
† Mycologia, vii. (1915) pp. 221–6 (1 col. pl.).
‡ Mycologia, vii. (1915) pp. 227–83.
§ Cincinnati, Ohio (June, 1915) pp. 291–392.
‖ Trans. Worcester Nat. Club, 1914 (1915) pp. 103–11.
¶ Mycol. Centralbl., v. (1914) pp. 13–19 (3 pls.).

primordia of the principal parts of the fruit-body, pileus, hymenophore and stem are endogenous in origin and are differentiated within the central portion. The enveloping zone of loose-meshed tissue is the "universal veil" or blematogen, homologous with a similar layer in *Amanitopsis vaginata*. The "partial veil" of these Agarici is a structure *sui generis*, being formed by the downward and inward growth of the margin of the pileus primordium, and forms the annulus or ring.

In *Agaricus campestris* there is an additional "universal veil" consisting of a delicate floccose layer which becomes torn into patches.

Studies in the Physiology of Parasitism.*—W. E. Brown has been able to advance our knowledge of parasitism by his experiments with the mycelium of *Botrytis cinerea*. He obtained a powerful extract by germinating the spores and extracting the juice from the germinating tubes. This solution he applied to living tissues and reports the results.

The action of the fungus extract he found was twofold: (*a*) Action on the cell-wall, leading to disintegration of tissue (macerating); and (*b*) action on the protoplast, producing death (lethal). He found that lethal action took place at a late phase of maceration. Accounts of the different experiments are given.

The extract may be rendered innocuous by heating, by mechanical agitation, and by neutralization with alkali. "Deactivation," the term used by Brown, leads to the loss of the lethal power of the extract.

The active substance of the extract appears to be the enzyme, which dissolves the middle lamella and causes the death of the cell by direct action on the protoplasmic membrane, or indirectly as a result of the action on the cell-walls. Certain tissues are able to resist the action of the fungus owing to special properties of their cell-walls. Neither oxalic acid nor oxalates play any part in the toxicity of the extract. If any special lethal substance is present it must be of colloidal nature.

Fungi as Cellulose Destroyers.†—F. M. Scales has investigated the action of filamentous fungi on cellulose in soil such as humus, etc. He found that fungi were even more effective than bacteria in their action on cellulose. In the course of experimentation nineteen species of cellulose-destroying filamentous fungi were identified, and two new ones found. One of these latter was found to produce a very active cytase. Cultures were also made with ammonium sulphate and with peptone as the source of nitrogen supply. With the latter many of the organisms failed to attack the cellulose. It is suggested that this is due to the carbon in the peptone which was utilized by the fungus, and satisfied its requirements.

Diseases of Onions.‡—Jun Hanzawa has discovered a new fungus disease of *Allium Cepa* due to *Fusarium Cepæ* sp. n. The plants that are attacked and can be detected by the decolouration of the leaves which fall towards the ground. The whole plant loosens from the soil

* Ann. Bot., xxix. (1915) pp. 313-48.
† Bot. Gaz., lx. (1915) pp. 149-53.
‡ Mycol. Centralbl., v. (1914) pp. 4-13 (2 pls.).

and the bulbs are gradually destroyed. The disease is not epidemic and does not spread over a whole field. The *Fusarium* forms sickle-like conidia and roundish chlamydospores; it can be easily cultivated on artificial media.

The author calls attention to other species of the genus that attack the onion or allied plants. He adds notes as to the best method of treating the disease.

Other parasitic fungi affecting onion plants are described, *Macrosporum parasiticum*, *Cladosporium alliorum* sp. n., and *Alternaria tenuis*, which attack the leaves. Others that attack stored bulbs are also recorded.

Diseases of Plants.*—Gy. Molnar has observed the hibernation of the powdery-mildew of the vine, *Uncinula necator*, in hot houses. The mycelium of the previous year still formed a grey covering to half-withered peduncles, and during the forcing season resumed activity, new conidiophores and conidia being produced. On the buds of the vines there was often a dense mycelium, and the conidia of the previous autumn were germinating. On the inner scales he noted conidia in different stages of development. The writer also records his observation on the appearance and development of the perithecia. He recommends the collection and destruction of all leaves, etc., after the vintage.

W. Robinson † has published an account of a wilt disease of China asters prevalent in market gardens round Manchester and known locally as "black neck." The aster may become diseased at any stage: the lower part of the stem shows a distinct browning or blackening of the tissues for a short distance above the ground level, the cortical tissues become decayed and the whole of the plant dies down. The fungus causing the disease was proved to be a species of *Phytophthora*; the sporangia showed characters similar to those of *P. omnivora*, but after the discharge of zoospores the stalk of the sporangium grows through and produces a second and even a third sporangium within the first. No sexual organs were observed.

Dezsö Hegyi ‡ describes a disease of red clover in Hungary due to an attack by the fungus *Glœosporium caulivorum*; during flowering the plants turned black and withered. Though sporadic the disease is serious, and is probably disseminated along with the clover seeds.

The author § recommends that these should be soaked before sowing in a 1 p.c. solution of copper sulphate.

The same author records a disease of cabbage lettuce due to *Marssonia panattoniana*. The outer leaves are attacked and finally destroyed. The disease first shows itself as elliptical patches on the principal veins. Destruction of diseased plants and disinfection of the forcing frames is recommended.

* Ampelol. Int. Eok., v. (Budapest, 1914) pp. 100–1 (9 figs.). See also Bull. Agric. Intell. Rome, vi. (1915) pp. 635–7.

† Ann. Appl. Biol., ii. (1915) pp. 125–37 (2 pls.).

‡ Mezö Szemle, xxxiii. (Budapest, 1915) pp. 55–58. See also Bull. Agric. Intell. Rome, vi. (1915) p. 637.

§ Kerteszet Budapest, i. (1914) pp. 97–9. See also Bull. Agric. Intell. Rome, v . 1915) p. 637.

J. B. Rorer * directs attention to the diseases of Cassava (*Manihot* sp.) in Trinidad. The question has become important there as the cultivation of the plant has very much increased of late years. He finds the leaf-diseases it is liable to are caused by several species of *Cercospora* causing leaf-spots, and by *Glœosporium Manihotis*, which attacks the petiole: the latter fungus also attacks the stem. On the roots there has been recorded a disease of little-known fungoid origin in Jamaica, and in the East a bacterial disease has been diagnosed.

A root-rot of tomato has been traced by Clara O. Jamieson † to the fungus *Phoma destructiva*. The fungus forms spots on the leaves of tomatoes and potatoes, and is an active wound parasite on ripe tomatoes. A long series of inoculation experiments were made and the vitality of the *Phoma* was found to be considerable; no more advanced fruiting stage was discovered.

J. W. Roberts ‡ has investigated the wintering of *Glomerella cingulata*, the fungus that causes bitter-rot of apple in America. He found that the fungus lived during the winter in mummified fruits, and also in cankers produced by the fungus, and there serve as a source of infection in the succeeding year. The cutting out of cankers and all dead parts of the trees should be carried out as far as possible.

James R. Weir § has identified *Rhizina inflata* as the fungus causing the death of pine seedlings. The white mycelium with which their roots were covered was believed at first to be that of *Armillaria mellea*, as it had penetrated the cortical and bast tissues which were choked with resin. Later in the season the fruiting bodies of *Rhizina* appeared, and inoculation experiments proved that it was the source of the mischief.

M. Savelli ‖ has investigated the fungus *Glœosporium musarum* with reference to the harm it causes to bananas exported to Europe from the Canaries. He describes the appearance of the fungus on the fruit; it causes splitting of the skin and rotting of the tissues. Cultures were made and the behaviour of the fungus in artificial conditions is described. It does not attack leaves in the open unless as a wound parasite.

J. Franklin Collins ¶ records the finding of chestnut bark disease on the fruits of the tree. The fungus *Endothia parasitica* forms elongate blisters on the nuts. In one case they were found on nuts still within the burrs. The writer warns the public as to the danger of disseminating the disease with nuts which are to all appearance healthy.

V. Oemun and P. J. Anderson ** describe the ravages in America of

* Bull. Dept. Agric. Trinidad and Tobago, xvi. No. 2 (1915) pp. 36–68. See also Bull. Agric. Intell. Rome, vi. (1915) pp. 996–7.

† Journ. Agric. Research, Washington, iv. No. 1 (1915) pp. 1–20 (8 pls.). See also Bull. Agric. Intell. Rome, vi. (1915) pp. 998–9.

‡ Journ. Agric. Research, Washington, iv. No. 1 (1915) pp. 59–64 (1 pl.). See also Bull. Agric. Intell. Rome, vi. (1915) pp. 999–1000.

§ Journ. Agric. Research, Washington, iv. No. 1 (1915) pp. 91–5 (1 pl.). See also Bull. Agric. Intell. Rome, vi. (1915) p. 1001.

‖ Ann. R. Accad. Agric. Torino, lvii, 1914 (Turin, 1915) pp. 184–92 (1 pl.). See also Bull. Agric. Intell. Rome, vi. (1915) pp 883–4.

¶ Phytopath., v. (1915) pp. 233–5 (1 fig.).

** Phytopath., v. (1915) pp. 260–5 (4 figs.).

cabbage-leaf spot. The green leaves of cauliflowers and cabbages are attacked by a fungus now described as *Phyllostirta brassicicola* which appear as minute black dots. The perfect fruiting form, *Mycosphærella brassicicola*, appears much later in the season. The connexion of the two forms seems to be correctly assumed, though it has not been proved. The outer leaves of the cabbage are attacked first. The disease has recently been introduced into America. It has long been known in Europe and in Australia.

Lichens.

(By A. Lorrain Smith, F.L.S.)

Lichens of Perthshire.*—J. A. Wheldon and Albert Wilson have published a list of lichens for this county compiled from various records, and added to by their own labours extending over a period of ten years, but they do not consider the record by any means exhaustive. They preface the systematic portion of the paper by an account of the physical and climatic features of the country with reference to the occurrence and growth of lichens. They divide the plants into three ecological zones: (1) the zone of cultivation and pasture; (2) the zone of closed moorland associations; and (3) the Arctic Alpine zone. There are many new records for the county. A new genus, *Pyreniococcus*, allied to *Obryzum*, is described, and several new species or varieties.

Ecological Study of Lichens.†—R. C. McLean has described the occurrence and distribution of lichens over a restricted seaside area at Blakeney Point, Norfolk. He describes the climatic conditions, one of the most important for lichens being a heavy dew-fall, and then gives a list of lichens found in the area. Where the ground was covered by grass, *Cladonia furcata* and *Cetraria aculeata* were abundant; when stones were in the ascendant, saxicolous species were dominant. He delimits a certain number of associations: Bare sand, on which are found plants of *Cladonia* and *Cetraria* probably blown there; grey dune, derelict dune, high shingle, loose shingle, round shingle, and low shingle, the plants found on these being enumerated. He then considers the "Distribution in relation to Edaphic Factors," that is, with regard to sand, humus, and mud, and correlated with these the relative stability of the substratum.

The growth of individual thalli was also watched. He decided that the fruticulose lichens were the most rapidly growing; the thallose species occupy an intermediate position, while the crustaceous species are the most slow growing of all. Marked lichens were tested as to the rate of growth, but the time covered by the experiments is not given.

Phases of life-histories, that is, the growth and decay of certain species, is touched on, and species with anomalous distribution are described. He concludes that lichens cannot be considered ecologically apart from the phanerogamic vegetation.

* Journ. Bot., 1915, Supplement, 74 pp.
† Journ. Ecology, iii. (1915) pp. 129–48 (3 figs.).

Caloplaca citrina.*—The autonomy and systematic position of this crustaceous lichen has been discussed by Carlo Zanfrognini. He cites the opinion of systematic authorities as to its relation to *Caloplaca murorum*, of which it is considered to be a leprose form by many lichenologists. Zanfrognini has himself studied the lichen and has concluded that it is an autonomous species; it is always granular in every variety of habitat and differs in internal structure from the lobate Caloplacaceæ. He contrasts with it other somewhat similar species, *C. murorum*, *C. cirrochroa* and *C. medians*.

Schizophyta.

Schizomycetes.

Bacterial Flora of the Normal Mouth.†—Z. A. Braïlovsky-Lounkevitch has conducted an exhaustive research having for its object the investigation of the normal buccal flora at various periods of life.

Among children, soon after birth or in the first few hours of life, the mouth cavity was found to be completely sterile, but after the lapse of several hours the mouth becomes rapidly populated with bacteria. The prevailing species observed was *Streptococcus salivarius* and its varieties, which was always present in smear preparations in the form of scattered diplococci. Other organisms commonly present were *Staphylococcus albus*, the pneumococcus, *Streptococcus pyogenes*, *B. coli* and *B. bifidus*, but these organisms were regarded as accidental saprophytes. The normal flora in the early period of life is aerobic, or facultative anaerobic, a strict anaerobe such as *Parvulus* rarely making its appearance.

With the eruption of the teeth the buccal flora changes in character, and numerous strict anaerobes are added to the characteristic flora of the newly born. The anaerobes most commonly observed were *Leptothrix buccalis*, spirochætæ, spirilla, vibrios, *Parvulus*, and *B. anaerobius gracilis*. From this time onward no essential change in the buccal flora is observed. The various organisms isolated appeared to have a predilection for certain situations—for example, facultative or strict anaerobes were most frequently found on the tongue (where they doubtless found conditions more favourable to growth than on the surfaces of the cheeks or palate), whilst diplococci were most in evidence on the cheeks, palate and tonsils. A marked resemblance was observed in the flora from corresponding regions of the various healthy mouths examined.

True proteolytic anaerobes were not met with in normal healthy mouths, and pathogenic species of bacteria, when they occurred, were found to be in a state of attenuated virulence.

Resistance to Chemical Agents of Certain Strains of Bacillus subtilis.‡—M. P. Portier has isolated from the larva of *Tenebrio molitor* (Coleoptera), and the larva of *Myeloïs Cribrella* (Lepidiptera), a bacillus

* La Nuova Notar., xxvi. (1915) pp. 155–65.
† Ann. Inst. Pasteur, xxix. (1915) pp. 379–404.
‡ Comptes Rendus, clxi. (1915) pp. 397–99.

belonging to the *Subtilis* group, which is extraordinarily resistant to the action of many chemical agents.

The organisms were sown in ordinary, or glycerinated broth, or better still in glycerinated yeast-broth. Fragments from the resulting wrinkled scum, typical of this group of bacteria, were removed and added to solutions of the various chemical agents for the desired periods of time. The solutions were then removed and replaced by sterile distilled water or 95 p.c. alcohol, the process being repeated till all traces of the original solutions were removed. The particles were aseptically transferred to broth and incubated at 40° C.

The duration of the resistance observed in the different solutions studied were as follows :—Phenol 5 p.c., more than 50 hours ; formol 30 p.c., more than 25 hours ; 0·1 p.c. tincture of iodine, between 24 and 48 hours ; Bouin's fixation liquid, between 13 and 24 hours ; alcohol 65 p.c. and 95 p.c., more than 14 months ; oil of cloves, more than 4 hours ; oil of turpentine, more than 15 hours ; cedar-wood oil, more than 15 hours ; and chloroform, more than 14 months.

Intermediate Group of Anaerobes in War Wounds.*—S. Costa and J. Troisier describe a group of anaerobic organisms isolated from the lesions of the wounded, the biological characters of which appear to be intermediate between *B. perfringens* and *B. œdematis maligni*. These bacteria are strict anaerobes, of large size with blunt extremities, are Gram-positive, and grow singly or in short chains. They produce abundant gas in sugar and albuminous media, pigment being deposited at the bottom of the culture tubes. In the latter respect they resemble *B. perfringens*, but in their motility and in the formation of subterminal spores they are closely allied to *B. œdematis maligni*. The motility is latent, being absent in sugar media, but being very marked when the organisms are grown in pepton broth, 7 parts, to which 1 part of alkaline egg albumin (Sacquépée and Delater) has been added. With regard to hæmolysis, the bacilli forming this group differ among themselves, but generally speaking the reactions are mid-way between *B. perfringens* and *B. œdematis maligni*.

A table is appended giving the various reactions of the five strains isolated. All the organisms were pathogenic for the guinea-pig, producing hæmorrhagic œdema, gas, and local digestion of the tissues.

Soil Protozoa and Soil Bacteria.†—In this communication E. J. Russell criticizes certain conclusions arrived at by Goodey, in which the latter definitely asserts that ciliates, amœbæ and flagellates cannot function as a factor limiting the numbers of bacteria in soil.

Goodey inoculated cultures of various Colpoda (*C. cucullus*, *C. maupassii*, *C. steinii*), a Vorticella (*V. microstoma*), and an unidentified amœba and a flagellate, into partially sterilized soils free from protozoa, and made periodic bacterial counts. The numbers of bacteria fell off, but not to any greater extent than in similar soils to which no additions of protozoa were made. He therefore concluded that such protozoa

* C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 430–3.
† Proc. Roy. Soc., Series B, lxxxix. (1915) pp. 76–82.

cannot be included in the biological factor limiting the number of bacteria in soil.

Russell points out that these organisms are in the main those which figure largely in cultures made by adding soil to hay infusions, and that there is no evidence that the normal soil fauna were put back into the partially sterilized soil, nor that the added organisms survived at all. Moreover Goodey did not appear to have overcome the great difficulty of securing an adequate control. When a soil is partially sterilized by heat, antiseptics, or prolonged storage, other changes are produced besides the destruction of the limiting factor and the protozoa. Some ammonia is formed and the amount of soluble matter is increased—both evidence of a change in soil constituents—and within a few days after remoistening, great numbers of bacteria and of their decomposition products accumulate. Hence by adding protozoa to (*a*) untreated soil containing normal numbers of bacteria and protozoa, and (*b*) partially sterilized soil, changed somewhat, and containing abnormal numbers of bacteria and their products, the organisms in the second case are placed under unfavourable conditions for development; in addition to this the added protozoa are contaminated with hay infusion and bacteria. Hence no clear issue is obtained between soil protozoa on the one hand and soil bacteria on the other.

Etiology of Typhus Fever.*—H. Plotz, P. K. Olitsky and G. Baehr† record the isolation of a bacterial organism which they have regarded as the causal agent of typhus fever. The bacterium in question is a strict anaerobe, and was first isolated by the application of Noguchi's methods for the cultivation of spirochætes. The best growth, however, was obtained on serum glucose agar, on which it forms opaque rounded colonies at a depth of 3 cm. or more below the surface of the medium. The organism is small (0·9–1·93 μ in length), pleomorphic and Gram-positive. It is non-motile and non-acid-fast and has no capsule. It may be straight or slightly curved, with rounded or slightly pointed ends. Coccoid forms are also met with, and involution forms occur early; spores do not occur. It ferments glucose, maltose, galactose and inulin with production of acid without gas. Growth in artificial media is slow. The reaction of agglutination and fixation of complement are present when the organism is brought into contact with a specific serum, and precipitation occurs in a mixture of such serum and bacillary extract. Monkeys are readily susceptible to typhus infection, which can be induced by injections of a patient's blood both before and after the crisis. The organism has been named *Bacillus typhi exanthematici*, at the suggestion of W. H. Welch, the name having been originally suggested by Klebs for the hypothetical infective agent of the disease.

Destruction of Locusts by Biological Means.‡—F. d'Hérelle has previously described a method of destroying locusts by means of insufflations of cultures of *Coccobacillus acridiorum*, the causal organism

* Lancet (1915) ii. pp. 876–7.
† Journ. Infect. Diseases, xvii. (1915) No. 1, pp. 1–68.
‡ Comptes Rendus, clxi. (1915) p. 503–5.

of locust disease. A difficulty which obtruded itself in his earlier work arose from the impossibility of keeping exalted cultures up to standard virulence. During the locust destruction campaign in Tunis in the present year, d'Hérelle has devised a new technique which has given exceedingly satisfactory results. Starting from a culture of the bacillus, passages are effected until the bacillus arrives at such a state of virulence that the death of the experimental locusts follows an injection, in less than eight hours. Immediately after the death of the insects, the bodies are dried carefully in a sulphuric acid dessicator at the laboratory temperature, and after pulverization, placed in small glass tubes, which are subsequently sealed off in the Bunsen flame. In these conditions the virus conserves itself without alteration for at least two years. When required for use, a tube is opened, emulsified with sterile distilled water, and cultures therefrom made on agar at room temperature. Sub-cultures are then made in broth consisting of 5 grm. pepton, 5 grm. meat extract, and 5 grm. of sodium chloride per litre. During the course of the campaign the fresh bodies of infected locusts are collected, and then dried and pulverized as above described, the powder obtained being used for starting the infestation in the following season.

Disease of the Tomato.* — V. Peglion describes a disease of the tomato which is characterized by withering of the leaves and stalks. The disease is practically limited to the vascular regions, which become brown and soft. Cultivations made on gelatin and agar showed a short non-motile bacillus in roundish colonies, at first white, afterwards becoming yellow. The disease was reproduced by inoculating healthy plants with pure cultures. The bacillus would appear to belong to the group of vascular bacteria described by Erwin F. Smith. The disease seems to be the same as that prevalent in America, but differs therefrom in that it is more localized and circumscribed.

* Atti R. Accad. Lincei, xxiv. (1915) pp. 157-60.

MICROSCOPY.

A. Instruments, Accessories, etc.*

(3) Illuminating and other Apparatus.

Chromoscopic Filter.†—This simple apparatus, J. Salkind says, presents transparent and colourless objects coloured on a white background. Ordinary microscopic observation of such objects (living cells, etc.) fatigues the eyesight in consequence of the necessity of detecting the minutest refractive differences, many a detail eluding notice in the uniform greyish-white of the preparation; moreover, the necessity of a high diaphragm power deprives the objective of the marginal rays so important for the resolution of fine structures.

The chromoscopic filter, intended to remedy these inconveniences, essentially consists of a glass or celluloid disk of dimensions suitable for its introduction into the Abbe apparatus. This disk is uniformly coloured and is centrally perforated by a circular aperture. Theoretically, observation with the chromoscopic filter holds the mean between vision by transmitted light and that with the ultramicroscope. Thanks to the filter, the most oblique rays of the condenser are coloured rays; they are reflected and refracted by the object and penetrate the objective. At the same time the background of the preparation is colourless, for the centre of the mount—optically homogeneous and of minimum refraction—transmits to the objective only the white rays of the central bundle. Moreover, according to the specific refractive index of the different parts constituting the object, these parts appear either coloured or white.

It being granted that the conditions necessary for the realization of the chromoscope vary with—(1) the numerical aperture of the objective; (2) the refractive index of the immersion medium placed between a given condenser and an object-slide of given thickness; (3) with the refractive index of the object and of its mount-medium—it would seem that the observer should possess a large number of filters with central apertures of varying diameters (or a transparent and coloured iris-diaphragm). But in practice, if a condenser of numerical aperture 1·40 be used, with cedar-oil as the immersion liquid, it will suffice to have a single filter with central aperture of about 5 mm. diameter (the aperture varying a few millimetres according to the colour intensity of a given disk). Correction is performed by means of two star diaphragms superposable on the filter; the first, with a dull centre, serves to diminish the brightness of the background, thereby intensifying the colour of the

* This subdivision contains (1) Stands: (2) Eye-pieces and Objectives; (3) Illuminating and other Apparatus; (4) Photomicrography; (5) Microscopical Optics and Manipulation; (6) Miscellaneous.

† Soc. de Biologie, lxxviii. (1915) pp. 382–3.

object; the second, with a black ring, intercepts the rays of medium obliquity, which cause a coloured veil in strong objectives and in immersions. It is possible also to use a star diaphragm with a centre tinted complementarily to the filter, the result being double colorations. The other conditions for producing chromoscopic images are: (1) use of daylight or of a light-source of large extent; (2) use, by preference, of a condenser of large aperture, and, in all cases, joining the object-slide to the condenser by a drop of liquid.

As illumination by the short waves affords the maximum of resolution, it is advantageous to employ the violet filter for direct observation: the red, inactinic, chromoscopic filter is favourable for photography. To appreciate the services which chromoscopy can render, the author recommends the observer to try the effect on fresh blood (leucocytes with their nuclei coloured in contrast with the red corpuscles), infusoria, and vegetable sections.

Adaptable Eye-shade for Microscopic Use.*—S. G. Shattock draws attention to the advantage which is derived from cutting off the access

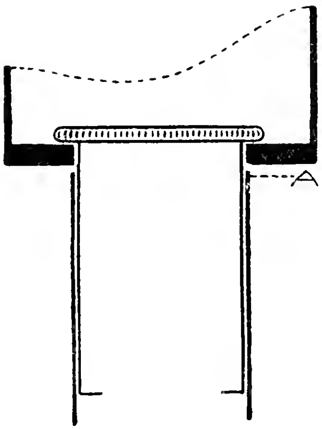

FIG. 65.

of direct light to the eye above the ocular. In working in a darkened room with a hooded lamp this drawback does not of course arise. But when daylight is used the admission of light to the eye above the ocular is a distinct hindrance to the study of fine detail. The difference can be at once brought home by temporarily shading the eye with the hand so as to improvise a dark chamber above the ocular. The ability to see more minute details with an eye-shade and a consciousness of diminished strain will become so apparent, that once used, it is certain the device will be afterward invariably resorted to for any prolonged microscopic study. Mansell J. Swift, who makes the device, told the inventor that binocular Microscopes were occasionally fitted with shades, but these (as in the

* Brit. Med. Journ., ii. (1915) p. 504 (1 fig.).

case of field-glasses), were fixed adjuncts. As the use of binoculars for histological purposes became obsolete, the advantage of the shade appears to have been lost sight of.

The drawtube of all Microscopes at the present time is made of a standard inside diameter known as No. 1, namely 23·3 mm., and this is the size adopted for the aperture in the floor of the shade through which the ocular drops; but the aperture is made also of a larger size to correspond with Standard No. 2, namely 26 mm., and it can of course be cut so as to take an ocular of any other dimension. It is hardly necessary to add that the shade can be used for either eye by rotating it so that the higher part corresponds with the outer receding margin of the orbit. The diagrammatic section, fig. 65 (natural size), shows the shade in situ, as kept in position between the flat upper edge of the draw-tube A and the rim at the top of the ocular. The form of the upper opening of the shade is indicated by the dotted line.

(6) Miscellaneous.

Microscopical Characters of Volcanic Tuffs: a Study for Students.*—L. V. Pirsson aims at the systematic treatment of the characteristics of tuffs, which he classifies into (1) vitric, (2) crystal, and (3) lithic tuffs. The subject is microscopically treated with the view of elucidating the type features. But it must not be supposed that all tuffs will clearly fall into one or other of these three classes. While many will doubtless do so, the majority of these rocks will be found to be intermediate in character; for all gradations between the three will be found in nature, with the exception that tuffs composed of glass dust with stony ash particles, but devoid of individual mineral crystals, must be extremely rare, if indeed they occur. The most common kinds are those containing in variable proportions all three ingredients. Tuffs may also be fresh, altered, or metamorphosed, and the author deals further with his subject from this point of view.

B. Technique.†

(1) Collecting Objects, including Culture Processes.

Bacterial Test for Plant Food Accessories (Auximones).‡—W. B. Bottomley has elaborated a bacterial test for plant food accessories ("auximones"). These auximones are obtained from an alcoholic extract of bacterized peat, the fractions of such extracts obtained by means of phosphotungstic acid and by silver and baryta giving good results with wheat plants. Cultures were obtained by placing 10 grm. of garden soil in a flask containing 100 ccm. tap-water, 0·1 grm. $(NH_4)_2SO_4$, 0·1 grm., K_2HPO_4, and 0·2 grm., $MgCO_3$ (Winogradsky's

* Amer. Journ. Sci., xl. (Aug. 1915) pp. 191–211 (6 figs.).

† This subdivision contains (1) Collecting Objects, including Culture Processes; (2) Preparing Objects; (3) Cutting, including Embedding and Microtomes; (4) Staining and Injecting; (5) Mounting, including slides, preservative fluids, etc.; (6) Miscellaneous.

‡ Proc. Roy. Soc., Series B, lxxxix. (1915) pp. 102–8.

medium) and incubated for seven days at 26° C., at the end of which period the liquid showed a strong reaction for nitrates. The effect of the auximones was tried on subcultures from these growths. At the end of forty-eight hours all the flasks to which auximone had been added showed a thick scum on the surface of the liquid, and at the end of six days were found to contain no trace of nitrate, while in the control flasks, without auximones, no scum had developed and nitrification had proceeded normally. These scum organisms, which were present in the original soil cultures, showed two predominant types of organisms: a thin beaded form and a spindle-shaped form. It was found that the presence of both these forms was necessary for scum formation, as when either organism in pure culture was grown in nitrifying solution plus auximone, characteristic scum never developed. The best results were obtained from new loam from a virgin field, though loams, clay, and gravels also gave positive results. A stock for experimental purposes can be obtained by sterilizing soil, putting aside for a week, and then saturating with a suspension of scum-forming organisms. The stock is then allowed to dry down at room temperature under sterile conditions, and stored in a bottle. This stock can be depended on to yield a good growth of scum in from two to three days in the presence of auximones.

Methyl-violet as a Means of Differentiating the Coli-typhoid Group.*—A. Botez has elaborated a new technique, based on the reduction of methyl-violet as a means of differentiating members of the coli-typhoid group of organisms. A stock solution of methyl-violet (5B) is made up to the strength of 5 parts per 100, and 0·2 ccm. of this solution is added to each 10 ccm. tube of broth. In this medium *Bacillus typhosus* gives no change even after fifteen days, *B. paratyphosus A* gives partial change, the colour of the medium becoming pale violet, while *B. paratyphus B* and *B. coli* destroy the colour completely in forty-eight hours; the original colour of the broth re-appearing. Similar results are obtained on agar plates if methyl-violet in the same proportions is added to the agar before pouring the plates. The reduction of methyl-violet by certain organisms, and the non-reduction by others, is said to be a new distinctive characteristic, the reduction processes involved being as yet uninvestigated.

Method of Collecting Diatoms from Surface of Mud.†—O. Kendall states that the following method will be found to be of great help in gathering material free from excess of sand and foreign particles, especially on the shores of tide-water. The method requires that the surface of the mud be uncovered by the tide. The spot for working is found by the presence of a brownish coloured film, generally in streaks or patches, on the sand surface. It has been found that by removing the film of diatoms with a spoon large quantities of sand and mud are taken up at the same time, making its removal difficult in the cleansing process.

* C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 489–90.
† Trans. Amer. Micr. Soc., xxxiv. (1915) pp. 53–4.

The collector is to provide himself with several squares of well-washed cotton cloth, about the size of a handkerchief, and be at the ground at low tide. Take a square of cloth and carefully lay it down on the mud surface in a way not to include air-bells. The cloth will in a few moments become wet, and may then be raised by one corner first and folded up with the side that was next the mud on the inside. After folding wrap in waxed paper and label for future reference. When ready to clean, place the cloth in a porcelain evaporating dish, and cover with strong sulphuric acid and enough bichromate of soda to make the mass a deep reddish colour. Place the dish in a sand-bath over a gas-stove or other source of heat, boil the mass till crystals of chromic acid appear as scum on the surface of the liquid. Remove and let cool. and pour into a preserve-jar partly filled with water. Let settle for at least half an hour undisturbed, then siphon off the water with a rubber tube to within 1 in. of the bottom of the jar, being careful not to disturb the sediment. Repeat the washing till clear from all colour. The sediment may now be removed to a small bottle and examined, and if a small quantity of sand be present it may be removed by whirling it with some water in the evaporation dish by means of a glass rod, and the sand will be found to pile up in the centre as a dark spot. Carefully pour off the water with the diatoms suspended in it, leaving the sand in the dish. It is surprising how the diatoms will stick to the cloth, and how little foreign matter will be collected by this method.

Useful Medium for the Bacteriological Examination of Fæces.* C. G. Delta recommends the following medium. To 100 c.cm. of 3 p.c. agar, slightly alkalin to litmus, are added (1) $1\frac{1}{2}$ grm. of lactose, or any sugar, dissolved in 4 c.cm. of distilled boiling water, and further boiled half a minute; (2) 10 c.cm. of $\frac{1}{2}$ p.c. aqueous solution of acid fuchsin, brought to boiling point and discolourized by adding four drops of a normal solution of sodium carbonate, and by boiling again until it assumes a port-wine colour. The agar thus prepared presents all the advantages and disadvantages of Endo's medium, but also has its own special advantages, namely, it is very easily prepared from staple solutions and is not affected by light. Furthermore (should one wish to make this medium more differentiating), there may be added nutrose or caffein, or malachite green or crystal violet (10 drops of 1 p.c. in 1000 solution). In the last two combinations the background is green or blue, and the *Bacillus coli* colonies are violet or red.

New Medium for the Culture of the Meningococcus.†—G. Faroy and Chavaillon recommend the following medium for the cultivation of the meningococcus, as a substitute for the usual ascitic agar medium. It is easily prepared, and, provided a stock of agar is kept on hand, is eminently suitable for travelling or field laboratories. 100 c.cm. of sterile horse serum is poured into a sterile flask containing glass beads, and to this 20 c.cm. of white of egg are added. (The large extremities of the eggs are sterilized in the flame and pierced with a sterile forceps, the

* Lancet (1915) ii. p. 1053.
† C.R. Soc. Biol. Paris, lxxviii. (1915) pp. 455-6.

egg-white being drawn up into a sterile Pasteur pipette.) The resulting mixture is then shaken vigorously for five or ten minutes, until the liquid is homogeneous and free from lumps of albumin. One then prepares a sufficient quantity of 2·5 p.c. neutral agar, to which 0·2 c.cm. of a solution of caustic soda (10 parts per 100) has been added per litre. One part of the serum-egg mixture is then added to three parts of the agar mixture (heated to 100° C. and then cooled to 50° C.), the resulting medium being then sloped in the usual way.

The new medium has given excellent results in the author's hands, both with cerebro-spinal fluid and with naso-pharyngeal exudates containing the meningococcus.

(2) Preparing Objects.

Preparation of Crystals.* — R. Pettigrew gives the following method of preparing crystals referred to in "Melting Crystals," which appeared in vol. ii. of the "Micrologist."

Camphor monobromide crystals are added to natural Canada balsam, the mixture being gently heated in a test-tube, and crystals added successively until, on cooling, the mass solidifies; about three times as much of the camphor as of balsam will be found necessary. When required for preparing slides, melt the mass by gently warming over a spirit-lamp, take a drop out with a warm glass rod, put a drop about a quarter of an inch on a warm slip, and cover and press down with a warm cover-glass. When cool scrape away the excess and ring with gold-size. When warmed to about 70° C.—by holding a lighted match underneath the reversed slide—the material will melt and, on cooling, gradually crystallize. If the match used for heating be held so that all but just a little at one edge is melted, the growth of crystals will start from the unmelted portion more quickly than if all be melted. By arranging the amount of camphor monobromide, the time of growth may be shortened or lengthened at will, but, generally, best results are obtained from a very thin layer, and which takes about one minute to start growth. If some tiny air-bubbles be left in on mounting, they are of value, as the growth, on touching the air-bubble, will go off with a rush, pushing the air-bubble in front of it in a zig-zag line. It is not necessary to make different tubes of material. If quick growth be required, choose a medium growing sample, and add some crystals of monobromide to a drop on a slide; if a slow growing sample, a little balsam.

Preparation of Chick Embryos.†—A. Flatters gives the following method of preparing, staining, and mounting chick embryos. The eggs are taken out of the incubator one at a time, the pointed ends cracked, and the shell picked off sufficiently to allow a clear view of the embryo. The bottom half of the shell, containing the embryo, is now placed in a dish of water kept at 105° Fahr., and allowed to rest on the bottom of the dish, the broken edge of shell and exposed embryo standing above the water line. The tissues of attachment are now severed and the

* Micrologist, iii. (1915) p. 22.
† Micrologist, iii. (1915) pp. 17–21.

embryos are removed from this solution and are transferred to a solution of formalin in water. After thirty to forty-five minutes the embryo floated on to the water, and then transferred, by means of a broad lifter, to the killing and fixing solution, consisting of a 5 p.c. third dish, containing 25 p.c. alcohol; after another two hours they are graded through an ascending series of alcohols up to 92 p.c., in which they are allowed to remain. Formalin fixation is serviceable when the embryos are to be mounted whole, but where sections are required a more precise fixative solution should be employed, such as Fleming's fluid or picro-formo-acetic solution. The latter solution is formed by mixing standard aqueous solution of picric acid 75 parts, formalin 25 parts, and acetic acid 5 parts. After three hours the fixative is washed out with 25 p.c. alcohol, and graded up to 92 p.c. alcohol.

Staining and Mounting.—Mayer's formula for hæmacalcium gives specially good results, and prevents the danger of swelling which is encountered with the use of hæmatoxylin in aqueous solution. Before staining, the specimens should be placed in 70 p.c. alcohol from fifteen to thirty minutes, to neutralize and prevent precipitation of the hæmatin. For staining entire embryos, 2 oz. of the stain is added to 6 oz. of 70 p.c. alcohol. The embryos are left in the stain for several hours, and, if necessary, the colour may be reduced by washing out with weak hydrochloric acid. The embryos are then left in 92 p.c. alcohol for two or three hours, then transferred to absolute alcohol for one hour, from which they are cleared in oil of terpineol, and mounted in benzol balsam.

For histological purposes special treatment of the embryos is necessary, i.e. infiltrating the specimens with paraffin, or permeating them with celloidine for sectionizing purposes. By the paraffin method the specimens fixed with picro-formo-acetic solution are dehydrated, and transferred successively to absolute alcohol and chloroform (six hours), chloroform (one hour), saturated solution of paraffin (130° Fahr.) in chloroform (three to six hours), and then to pure paraffin in a water-oven. After several changes of paraffin the specimens are moulded and cooled, and sections cut in the usual way. Sections may be stained with hæmacalcium. Xylol may be substituted for chloroform in the clearing process, cedar-wood oil being used between the alcohols and the xylol. Possibly terpineol might be used as a cheap substitute for the xylol.

The writer recommends the use of the celloidin method of embedding embryos, as the tissues are less liable to be injured than by the paraffin method. He only resorts to the latter method when it is impossible to obtain sufficiently thin sections without the aid of celloidin.

Collection and Preparation of Fresh-water Nematodes.*—Margaret V. Cobb collected fresh-water Nematodes by taking samples of the sand or mud and water of the pool or stream bottom and of the aquatic vegetation. These were washed through a series of graded sieves from coarse to fine which removed the coarser debris, until examination with a lens showed that Nematodes also were caught on the sieve. The collection was then allowed to settle for five minutes or more and the

* Trans. Amer. Micr. Soc., xxxiv. (1915) pp. 22–3.

superfluous water poured off. The Nematodes were killed and fixed by adding to this watery mud an equal quantity of boiling hot saturated solution of corrosive sublimate. For staining and mounting each sample was treated as follows: The sediment was examined, a little at a time, in a Syracuse watch-glass under a dissecting-lens; the Nematodes were picked out one at a time with a bamboo splinter and placed in water in the object-box of a differentiator, in which they were gradually passed up through upgraded alcohols to 80 p.c. At this point they were treated with acid-alcohol to dissolve out impurities (10 drops concentrated HCl to 100 c.cm. 80 p.c. alcohol), and overstained with acid carmine according to following formula: Carmine 4 grm., H_2O 15 c.cm., HCl 30 drops. Add 95 c.cm. of 85 p.c. alcohol, boil until the carmine is dissolved, neutralize with ammonia until carmine begins to precipitate, filter through glass wool. For differentiation of the tissues acid-alcohol was used (4 drops concentrated HCl to 100 c.cm. 90 p.c. alcohol). The specimens still in the object-box were passed up to and through absolute alcohol and turpentine to thin balsam. This was done without removing the object-box from the differentiator except to remove it to another type of differentiator when the change to heavier fluids began. The object-box was now opened in thin balsam in a Syracuse watch-glass and the Nematodes mounted in balsam. From ten to 100, according to size, can be arranged in one drop of balsam without much crossing of specimens. This is also best done under magnification; it is convenient to have two dissecting Microscopes, keeping the watch-glass of specimens under one and the slide which is being prepared under the other.

New Method of Examining Stools for Eggs.* — Vida Annette Latham reports that C. M. Fauntleroy and R. Hayden suggest the following method. 1. Mix thoroughly about 2 grms. of fæcal matter with 5 c.cm. of a 2 p.c. aqueous solution of lysol in a centrifuge tube. 2. Centrifuge at high speed for one minute, decant the supernatant fluid, and mix a fresh quantity of the lysol solution with the sediment in the tubes. Repeat this step three times. 3. Remove small portions of the centrifuged deposit with a pipette, place on slide, mix a small drop of anilin-gentian violet with the sediment, cover and examine. All eggs, hookworms, etc., stand out very clearly. Everything is stained except the eggs.

(5) Mounting, including Slides, Preservative Fluids, etc.

Euparal.†—Euparal, says H. L. Wieman, is a mounting medium composed of a mixture of camsal, sandarac, eucalyptol, and paraldehyde, and having a refractive index of 1·483.‡ It is put up in two forms, the colourless and the green, the latter containing a copper salt which intensifies hæmatoxylin stains. The colourless is preferable when stains other than hæmatoxylin are used. The primary advantage of this medium is that it spares delicate objects the usual treatment with absolute

* Trans. Amer. Micr. Soc., xxxiv. (1915) pp. 54–5.
† Trans. Amer. Micr. Soc., xxxiv. (1915) pp. 52–3.
‡ See also this Journal, 1907, p. 501.

alcohol, since objects may be mounted in it directly from 95 p.c. alcohol. It dries rapidly, so that preparations may be studied with safety at the end of twenty-four hours. Cover-slips may be removed from old preparations by immersion in 95 p.c. alcohol for several hours. Another useful property of euparal is its low index of refraction, which is well-adapted to cytological study, giving a much-desired increase of visibility to delicate elements. Another important feature is that it does not bleach the stain.

(6) Miscellaneous.

Development of Botanical Microtechnique.* — G. M. Smith describes the development of botanical microtechnique under the following captions. 1. The methods of the early microscopists (from the time of Hooke's discovery of the cell to 1800). 2. The technique of the English microscopists (1800–1875). 3. The methods of the German botanists (1800–1875). 4. The development of modern methods of microtechnique (1875 to the present). There is much useful information in the article which deserves the perusal of those interested in the historical aspects of microscopy. A copious bibliography is appended.

Metallography, etc.

Copper-tin Alloys.†—J. L. Haughton has studied the constitution of the copper-tin alloys in the range 55 to 65 p.c. tin, which is the range containing the ϵ constituent. The alloys were cast in a wedge-shaped mould made of thin sheet copper, surrounded by a freezing mixture. The very rapid solidification and cooling produced a fine structure which on subsequent annealing attained equilibrium in much less time than that required for alloys which had been cooled less rapidly. Specimens were annealed for 20 to 300 hours at 210°, 310°, and 390° C., quenched, and examined microscopically. At 59 p.c. tin the alloy annealed at 390° C. consisted of pure ϵ. With less tin η was also present, and with more tin the annealed alloy consisted of $\epsilon +$ eutectic. After annealing at 310° C. pure ϵ contained 59·5 p.c. tin. At 210° C. the composition of pure ϵ is between 59·8 and 61 p.c. tin. In all specimens containing any quantity of eutectic the ϵ was not coloured by the etching reagent used (ferric chloride in hydrochloric acid), while in the absence of the eutectic it etched dark, leaving the η as pale blue crystals. This formed a sensitive test for the presence of eutectic. Heating curves were taken. The author's conclusions are embodied in an equilibrium diagram for the range studied.

Microstructure of Base-metal Thermocouples.‡—O. L. Kowalke has microscopically examined transverse sections of thermocouple wires, annealed at various temperatures. Pure metals, or alloys consisting of

* Trans. Amer. Micr. Soc., xxxiv. (1915) pp. 71–129 (3 pls. and 12 text figs.).

† Journ. Inst. Metals., xiii. (1915, 1) pp. 222–48 (30 figs.).

‡ Trans. Amer. Electrochem. Soc., xxvi. (1914) pp. 199–214, through Science Abstracts, xviii. (1915) pp. 372–3.

one solid solution, were found to be the most constant in their thermo-electric behaviour.

Micro-chemistry of Corrosion: α-β Copper-zinc Alloys.*—S. Whyte has applied the methods previously described to an α-β alloy containing 60·8 p.c. copper and 39·2 p.c. zinc, to three alloys of similar composition but having 1 p.c. zinc replaced by 1 p.c. of iron, 1 p.c. of lead, and 1 p.c. of tin respectively, and to a pure α and a pure β alloy. Corrosion in sodium chloride solution was stimulated by an electric current, and the effects were determined by microscopical and chemical methods. β corroded more rapidly than α, and corrosion proceeded in all cases by dezincification. In alloys containing both α and β, the layer of copper formed was thicker over the β constituent than over α.

Appliances for Metallographic Research.†—W. Rosenhain describes a levelling device for metallographic specimens. A small, low-power telescope is rigidly fixed in a vertical position, with the eye-piece uppermost. A plane glass reflector, set at 45° to the axis, is fixed in the tube a little below the eye-piece. This reflects downwards the light admitted horizontally through a small hole in a plate at the end of a short side tube. A few inches below the objective a glass plate, silvered on its lower face, is adjusted accurately at right angles to the axis of the telescope, by bringing the image of the small hole on to the cross wires of the eye-piece. The specimen, mounted on a slip by means of plasticine, is placed on the glass plate and acts as the reflector: its level is adjusted until the image of the small hole again falls on the cross wires. The polished face of the specimen is then parallel to the lower surface of the slip on which it is mounted. The adjustment can be made in a few seconds. Some appliances for use in taking thermal curves are also described.

Etching Reagents.‡—O. F. Hudson discusses etching reagents generally, and gives a detailed description of the action of all the reagents in common use, and of many which have been used for special purposes. In an etched surface of a pure metal the appearance of the crystal boundaries as black lines may be due in part to the more rapid solution of the metal at the boundaries. Etching usually produces some roughening of the surface of each crystal, and staining due to a film of oxide. When two or more constituents are present, they are commonly stained to a markedly different extent, and such differences are employed to distinguish the constituents. The amorphous surface film produced by the polishing of a specimen does not as a rule seriously interfere with the effects produced by etching, but its presence should not be overlooked.

Electrolytic etching, polish attack—a method which the author believes is not adopted as widely as it should be—and heat-tinting are described. A list of metals and alloys, with the etching reagents suitable for each, is given.

* Journ. Inst. Metals, xiii. (1915, 1) pp. 80–99 (11 figs.).
† Journ. Inst. Metals, xiii. (1915, 1) pp. 160–92 (13 figs.).
‡ Journ. Inst. Metals, xiii. (1915, 1) pp. 193–221 (2 figs.).

National Physical Laboratory.*—Metallographical research work has been carried out upon the constitution of the aluminium-zinc-copper alloys, the effects of strain at high temperatures, and the inter-crystalline cohesion of metals. The new copper-depositing reagent for etching steel has been in constant use, and has given important results. An annealed steel, showing phosphoric banding when etched with the new reagent, was heated to 800° C. and quenched. It then consisted mainly of martensite-troostite, but certain regions consisting of ferrite were identified with the phosphoric bands of the original annealed steel. Their relatively high phosphorus-content had prevented the diffusion of iron carbide into the bands.

* National Physical Laboratory, Report for year 1914–15.

PROCEEDINGS OF THE SOCIETY.

MEETING

Held on the 20th October, 1915, at 20 Hanover Square, W., Mr. D. J. Scourfield, F.Z.S., etc., Vice-President, in the Chair.

The Minutes of the Meeting of June 16 were read and confirmed, and signed by the Chairman.

The following Donations received since the last Meeting were announced, and the best thanks of the Society accorded the donors :—

	From
Report of the British Antarctic Expedition, vol. i., Geological Section	*The Publishers.*
Chamberlain (C. J.), Methods in Plant Histology, 3rd edition	*The Publishers.*

Dr. Shillington Scales gave formal notice, in accordance with Bye-laws 100 and 101, that a Special Meeting would be held on November 17 at 6 o'clock to consider the suspension of Bye-law No. 76, so that the time of meeting of the Ordinary Meetings might be altered to 6 p.m. instead of 8 p.m., for so long as the Council should decide.

After some discussion, and on a show of hands being taken, it was agreed that the Special Meeting should be held at 8 o'clock instead of at 6 as at first proposed.

The Chairman then called upon Mr. E. Heron-Allen, F.L.S. F.R.M.S., who read his paper entitled "A Statement upon the Theory and Phenomena of Purpose and Intelligence exhibited by the Protozoa, illustrated by Selection and Behaviour in the Foraminifera."

The Chairman, in thanking Mr. Heron-Allen, said he was sure the Fellows would agree with him that they had listened to a most interesting address, and one that meant very much to them. The subject had been laid before them in a very lucid and striking manner, and the illustrative photographs were very beautiful and of exceptional value. He agreed with what Mr. Heron-Allen had said regarding the importance of the definition of terms. It seemed to him that some of the wonderful

instances of selection of particles would be a little more convincing if they were less regular, for after all they appeared to be practically the same thing over and over again without real purpose and intelligence as we understood those terms in the case of man. But that was no doubt somewhat a question of individual opinion. In any case he thought it would be admitted that the problem was not completely solved by saying that we were confronted by purpose and intelligence.

Mr. Maurice Blood said that he only wished to refer to a very tiny point. Did Mr. Heron-Allen believe that the introduction of the particles of heavy minerals and gems into the shells was beneficial? It would probably be a disadvantage on a bottom of soft ooze, but on clean sand it would undoubtedly bring their density nearer to that of the quartz grains and prevent their being carried away so easily by a gentle current.

Dr. Shillington Scales congratulated Mr. Heron-Allen on the interest of his paper and on the beauty of the slides accompanying it. Mr. Heron-Allen had devoted a very large portion of his life to the study of the Foraminifera, and he and Mr. Earland had enriched the Journal with many valuable monographs on the subject. It seemed to him, however, that his interest in the subject had led him to claim for the lower animals a portion at least of the intelligence which we are apt to give to the dog. He had to confess to finding a very great difficulty in discussing the point of view which Mr. Heron-Allen had put before the Meeting. It was not easy to realize where he left off and where he began. He did not claim intelligence for a great many of the physiological and developmental processes which existed in life. The selective processes of the Foraminifera were elementary compared with the developmental processes of the cells of plants as well as animals. It was difficult to understand why Mr. Heron-Allen should claim intelligence for the one and deny it to the other, or where he drew the line. Many processes could be explained by chemiotaxis, and some of Mr. Heron-Allen's problems with regard to the selection of certain minerals by the Foraminifera might possibly be explained on a similar basis. At a recent meeting a Fellow of the Society had alluded to the nature of crystallization, and had apparently claimed, in all seriousness, an equal degree of intelligence in crystals to that which Mr. Heron-Allen claimed for Foraminifera.

Mr. Heron-Allen replied that he was very glad to hear what Dr. Shillington Scales had to say, because he really voiced the views of the "Old Guard" which he knew would "never surrender." He said he wanted to know where he (Mr. Heron-Allen) began and where he left off. That seemed to him a very simple matter. He began and left off again as soon as he began! He simply postulated that the measure of purpose and intelligence which was exhibited by the Protozoa, and reached its highest development in man, was shown by the use of extraneous materials which the creature selects from its surroundings, and which it adapts to a particular purpose. He desired to go no further than that. It is not a question of the survival of the fittest, and there is no question of the adaptations, by which certain plants and certain animals develop certain integral parts of themselves that give

them advantages over their fellows. The thing which he claimed to be wrong was the introduction of anthropomorphic suggestions arising out of the words "purpose and intelligence," to define the faculties which lead to these phenomena in the lower animals. He recently had a very interesting correspondence as to this with Professor Flinders-Petrie, who had suggested a word with which he was far from satisfied, but which seemed to be the happiest which could be arrived at for the moment. He had discussed this in a note to the paper he had read, which would appear in due course in the Journal.

A very hearty vote of thanks was accorded to Mr. Heron-Allen for his exceedingly interesting communication, and the Meeting then terminated.

It was announced that the next Meeting of the Society would take place on November 17, at 8 p.m.

The next Meeting of the Biological Section would be held on Wednesday, November 3 (6.30 for 7), when Mr. Rousselet would make a communication on "The Resting Eggs of Rotifers."

New Fellow:—Albert James Hartland was elected an *Ordinary* Fellow of the Society.

At a Special Meeting of the Society (in accordance with By-laws 100 and 101), held on Wednesday, November 17, 1915, at 20 Hanover Square, to consider the suspension of By-law 76, so that the Ordinary Meetings of the Society might be held at an earlier hour, there were present Mr. D. J. Scourfield, F.Z.S., etc., Vice-President, in the Chair, and twenty-three Fellows.

The Chairman invited suggestions from the Fellows present as to the hour at which they might most conveniently meet, and after some discussion it was proposed by Mr. E. J. Sheppard, and seconded by Mr. C. E. Heath, that the Meetings be held at 8 p.m. as previously.

The motion having been put to the Meeting and a show of hands taken, the resolution was duly passed.

The Chairman then declared the Meeting to be an Ordinary one, and the Minutes of the Meeting of October 20 were read and confirmed, and signed by the Chairman.

The following Donation received since the last Meeting was announced, and the best thanks of the Society accorded the donor :—

	From
Bagshaw (W.), F.R.M.S., "Elementary Photo-micrography," 3rd edition, 1915	*The Author.*

A paper by Messrs. E. Heron-Allen, F.L.S., F.R.M.S., and Arthur Earland, F.R.M.S., entitled "The Foraminifera of the Shore Sands and Shallow Water Zone of the South Coast of Cornwall," was read. The paper was illustrated by a series of slides shown on the screen and described by Mr. Earland.

Mr. Earland, in introducing the paper, stated that it was to be regarded as a further instalment of the local records which the authors were amassing as a preliminary to a British Monograph, and this paper practically completed the area of the English Channel.

The paper was based on the examination of Cornish shore sands and one very rich dredging taken off Newlyn. In order to make the records as complete as possible they had included all published records from the district, and a number of unpublished records which had come into their possession from various sources, all of which are suitably acknowledged in the paper. This included a total number of 255 species and varieties, of which 221 occurred in their own gatherings.

As might be expected from the local geology, fossil derivatives were very scarce, as compared with gatherings made farther eastward in the Channel, but they had records of two common Cretaceous species, two Eocene, and of a single Pliocene specimen, *Faujasina carinata* d'Orbigny, which could only have originated in the Pliocene clays of St. Erth, many miles inland from the locality (Penzance) where it was found.

Three species were recorded for the first time as British, and a few others as British for the second time.

At the conclusion of the demonstration, the Chairman remarked that the Fellows had once again to thank Messrs. Heron-Allen and Earland for presenting to the Society the results of the valuable work they were doing in connexion with the Foraminifera found in various places around our coasts.

With regard to the discovery on the Cornish coast of Foraminifera derived from the chalk and Eocene beds, he would like to know whether the authors considered it possible that these specimens had drifted along the shore from the coast. He believed that there was some evidence from other sources which seemed to show that there was such a drift from east to west along the south coast, but it would be very interesting to have it confirmed by the distribution of the Foraminifera. As regards the characteristic species from the St. Erth beds found at Penzance, he suggested that wading birds might conceivably be responsible for the transmission. He also wished to ask whether more than the one pelagic form specially referred to had been found, as it seemed extremely

probable that the coast of Cornwall would receive occasionally some of the typically pelagic species from the Atlantic.

Mr. Maurice Blood asked whether there was any possibility of the inland forms being washed down by the streams and rivers to the sea, and thus drifting on to the coast.

He also inquired what Mr. Earland considered was the relation between *Orbulina* and *Globigerina*. Was the latter the immature form?

Mr. Earland replied that, as regards drifting of rock specimens, the late Mr. William Hill, F.G.S., a great chalk specialist, told him he had received specimens of chalk (from zones which, as far as he knew, were only exposed along the Sussex coast) from dredgings made right down the Channel to beyond Land's End. These had probably come down Channel with a westerly drift. But specimens of chalk had been dredged by himself between the Shetlands and the Faröe Islands, many hundreds of miles from localities where any exposure was known to exist. He was of opinion that these Faröe specimens had been deposited there during the glacial period, as there were great submerged moraines in the Shetland-Faröe Channel. Chalk fragments and fossils had also been dredged in deep water off the south of Ireland. He had little doubt, however, that the Cornish fossils had come westwards from higher up the Channel.

Regarding the next point, the occurrence of such an extremely local fossil as *Faujasina carinata* d'Orbigny many miles away from its only locus of origin was very puzzling, but there were many possible explanations for its presence, though none were satisfactory. The theory of its transportation by wading birds was possible, but he thought rather far-fetched. It was one of those things which could not be readily explained.

The next point was as to the occurrence of pelagic forms other than *Orbulina*. There were a few *Globigerina* records, but not many. As regards the life-history of *Orbulina*, this was still open to doubt, but the theory of Rhumbler, a great German authority was, that the spinous pelagic *Globigerinæ* secreted the spherical *Orbulina* shell as a protection for their delicate spines and shell, which thus became internal and superfluous and were gradually absorbed. The living pelagic *Globigerina* is covered by a radiating mass of long and extremely delicate spines, whose function was to increase the resistance to gravity, and so help to support the organism in the water.

Rhumbler's theory was quite sound, and in the opinion of the authors highly probable, but it was merely a theory and would require much experimental work to confirm it.

A hearty vote of thanks to the authors for their paper and demonstration was then proposed, and carried with acclamation by all present.

It was announced from the Chair that the next Meeting of the Society would be held on Wednesday, December 15, at 8 p.m.

It was further announced that the next Meeting of the Biological Section would be held on Wednesday, December 1.

New Fellows.—The following were elected *Ordinary* Fellows of the Society :—Frank Brewester, Mark Thomas Denne, Alexander Hopkins Thwaites.

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